

The changing faces of Europe's coastal areas

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Executive summary

This report provides information on the state of the environment in the coastal areas of Europe, and provides evidence of the need for a more integrated, long-term approach. Since 1995, concern about the state of Europe's coastline has led to a number of EU initiatives, which build on the concept of integrated coastal zone management (ICZM). ICZM attempts to balance the needs of development with protection of the very resources that sustain coastal economies. It also takes into account the public's concern about the deteriorating environmental, socio-economic and cultural state of the European coastline.

The specific objective of this work is to contribute to the review of the Recommendation of the European Parliament and the Council concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC), planned by the European Commission for 2006. This review requires information on existing trends and on the effects of policies and financial instruments directed towards coastal management.

The EEA intends to contribute to the review by promoting spatial analysis and enhancing the integration of relevant environmental data with related socio-economic data to the extent current available information allows. At the same time, the report aligns itself to the wider context of ecosystems and human well-being set up by the Millennium Ecosystem Assessment (2005). By linking ecosystems and human well-being, this approach focuses in particular on 'ecosystem services', i.e. the benefits people obtain from ecosystems.

Climate change and its impact on coastal zones is yet another important analytical framework that is taken into account while analysing the state of coasts. The increasing vulnerability of the coastal population and ecosystems becomes a challenge for the ICZM approach, which should achieve a reduction in these vulnerabilities through the coherent spatial organisation of coastal zones and by increasing the resilience of coastal systems.

By analysing the responses of society to unsustainable development trends, the report

reviews existing relevant policies and tracks how they may affect the coastal zones. However, analysing the effects of all these policies is a complex task for which there are not always sufficient data. Nevertheless, the report is intended to give a comprehensive picture of European policies concerning the coast, either directly or indirectly. The focus is weighted towards the EU ICZM Recommendation and follows the work undertaken by the EU Expert Group on ICZM, which selected two sets of indicators: a set of 27 indicators for measuring sustainability on the coast, and an additional set to measure the implementation of integrated coastal management in European countries. A number of case studies completed within this EU ICZM framework have also been included. The indicators also serve as examples for a more widespread adoption of integrated territorial management principles across Europe.

Testing indicators at Member State and regional level is especially important as the approach (laid out by the EU ICZM Recommendation) underlines the flexible and problem-oriented nature of adopted responses. Here, the EU follows the subsidiarity and proportionality principle by providing leadership and guidance to support implementation at other levels. It is also important to note that a European approach on ICZM builds on existing instruments and programmes which may not necessarily have been designed with coastal zones in mind.

The report serves the purpose of developing the EEA's approach on integrated spatial assessment with a view to understanding changes in coastal systems and monitoring progress towards sustainable development. It focuses mainly on the environmental dimension, which is used as an entry point to analyse the relationship between society and the natural environment in coastal zones.

The coastal zone in this report is interpreted as the resulting environment from the coexistence of two margins, namely: the terrestrial edge of the

continent and coastal water as the littoral section of shelf seas. Together they constitute a whole which needs a specific methodological approach, and dedicated planning and management methods.

The report follows this conceptual framework as much as possible, even though data availability has often been a limiting factor. Constraints also exist because models linking terrestrial drivers and water quality are still not fully developed or efficient enough to assess the changing conditions of the sea and coastal waters, and the pressure of human activities.

Despite these limitations, this report should constitute the first integrated spatial assessment of Europe's coasts. Added value is provided by the variety of data and information that have been collated and analysed (from environment, sectors, policies etc.), and the construction of a conceptual framework to make the coast more visible for the public and policy-makers. Previously unpublished information on land cover changes 1990–2000 for European coasts has been provided by applying EEA methodology on land and ecosystem accounts. This makes use of the Corine land cover data base.

Work on this report has also led to a review of the availability of data for such assessment and data needs for the future. In addition, it has allowed the construction of a GIS database for the European coast to begin. Advancing a data concept for coastal assessment lays a corner stone for building a data model for coastal zones, and contributes to establishing the infrastructure for spatial information in the Community (INSPIRE) and its implementing guidelines.

In the assessment, a number of priorities for action have been identified. The most important ones can be expressed as follows:

- Population sizes in Europe's coasts are continuously increasing, sometimes faster than in inland areas. Coasts are converted to man-made artificial surfaces at an even faster pace. There is a need to develop more information to better understand what is happening with built up areas and city planning in Europe, and to establish some thresholds and other planning tools to avoid uncontrolled sprawl.
- Infrastructure developments appear as a powerful driver of residential sprawl, soil sealing and heightened levels of mobility. They are also, together with urban sprawl, an important factor in fragmentation of coastal space.
- Numbers and figures from the Corine land cover data base describing changes between 1990 and 2000 show an important loss of habitats (e.g. pastures, mixed farmland, natural and semi-natural areas and wetlands), which are extremely relevant for biodiversity. This is a clear indicator of the need for action to mitigate these trends.
- Coastal shelf ecosystems are also being affected. A European map of sea grass communities is urgently needed. Sea grass communities are being degraded because of the persistence of turbidity in coastal waters, trawling and other causes. But data are still lacking by which to map the underwater habitats on a European scale.
- Contamination of coastal water significantly affects the capacity for coastal waters to be the nursery habitats for species that will return to deep waters. Land/sea models are needed to better understand how terrestrial sources affect the quality of coastal waters. Eutrophication is still an important problem in different regional seas.
- There is an urgent need to find more sustainable forms of tourism on the coast. Tourism appears to be the most important maritime activity especially in southern countries and also in the Baltic countries, Poland, South Finland etc. This activity has a very high spatial and seasonal impact. Tourism flows affect the whole of Europe. Urgent action is needed to build European awareness and promote respect for coastal areas, including economic tools to compensate for major externalities and enhance solidarity amongst European regions.
- There is a need to map and manage the activities that are growing very rapidly seawards (e.g. wind farms and other energy plants, ports and maritime traffic). This will require progress in spatial planning of coastal waters.
- Aquaculture is a sector that has a strong growth potential, but it is often considered a controversial issue. Data are needed to assess the relevance of aquaculture for fishery community needs in order to ensure economic feedback and control environmental externalities, including fish stock recovery.
- Due to these different pressures, the EU designated extensive coastal sites through its Natura2000 network (both on land and at sea) to protect the coast from further development, and ensure the quality of the coastal ecosystems and habitats. An initiative to create a network of marine protected areas, ideally connected by 'blue corridors', offers good prospects for marine ecosystem protection. However, the

management and follow up system of already established sites is still under preparation.

- A large number of coastal regions are amongst the EU's less favoured regions. Improving living standards of peripheral coastal communities is therefore an obvious challenge for cohesion policies. Sustainable socio-economic development is needed at regional and local level, and could be supported by EU funds through the enhancement of maritime activities using sustainable practices, coupled with a consistent monitoring of effects of the different actions on environment and society.
- The report identifies major coastal risks and assesses how and why to reverse the trends. To fight coastal erosion, the recovery of the sediment balance is needed. In light of this, a new concept of sediment management is highlighted.
- Looking to the future it is clear that the impact of global warming and climate change will become widespread. It will have a singular effect on the coast with rising sea levels, the increased probability of storm surges and associated coastal floods. However, increasing human vulnerability rather than physical magnitude or frequency of the events themselves is the prime factor underlying the rise in impacts. People are increasingly occupying the low-lying areas that are exposed to flooding, thus exacerbating their vulnerability to extreme events.
- Natural ecosystems have proved to be key in increasing coastal resilience and protecting the coast during hurricane episodes (e.g. Louisiana, September 2005) and even tsunamis, (south-east Asia, December 2004). Coastal wetlands, coastal dunes and beaches, inter-tidal flats, coastal forests etc. are the most effective defences in the case of these types of natural disasters. However, coastal ecosystems and habitats need space and

time to fully recover to be able to efficiently protect settlements and lives landwards.

- Results show that the EU's coast is made up of very diverse landscapes and cultural contexts. It is important to take stock of this diversity to avoid cultural and landscape homogenisation. There is a need to work more on regional sustainable development. Using a regional scope, islands need a specific approach as they have specific problems such as limited land availability, lack of water reserves, waste management etc.
- Policies for the EU's coasts have a long history but have not been implemented in an integrated manner so far. The situation today presents a great challenge. It also offers opportunities to promote the integration of river basins, coastal zones and marine regions and enhance cooperation with the water framework directive, European marine strategy and preparation of the European Maritime Policy. This should be seen within a sustainable development framework and the EU's ICZM Recommendation with the national ICZM strategies (to be issued in 2006). The implementation of all these different policies has great potential and represents a unique opportunity to create an integrated legislative framework for the sustainable development of the European coasts.

This report presents spatial information to support an integrated coastal policy framework. It represents a baseline to monitor the coast and should be updated in 2010 in accordance with the EU's ICZM strategy (2000). The EEA will support the revision of the strategy in conjunction with the assessment of the state of European environment. This new information can bridge present gaps and provide better regional assessments to fully understand the trends identified at European level.

1 Introduction

1.1 Purpose and key definitions

The 1992 Earth Summit of Rio de Janeiro recognised in its Agenda 21 the need for environmental action for oceans and coastlines (Chapter 17), and committed coastal nations to the sustainable development of their coastal areas and implementation of integrated coastal zone management.

According to the basic principles of sustainable development, all three dimensions of development – economic, social and environmental – need attention and should be treated together in a holistic way. This report focuses primarily on the environmental dimension, which is used as an entry point for analysing relationships between society and its natural environment in coastal zones. By linking the state of the environment with natural resources (e.g. land, water, sediments, energy, biodiversity) and constraints (e.g. natural and industrial risk, pollution), the report extends to living conditions on the coast and aims at an integrated approach.

The specific objective of this work is to contribute to the review of the Recommendation of the European Parliament and of the Council concerning the implementation of Integrated Coastal Zone Management in Europe (2002/413/EC) planned by the European Commission in 2006. This review requires information on existing trends, and the effects of policies and financial instruments on coastal management.

Integrated coastal zone management (ICZM) promotes an integrated approach that involves all relevant stakeholders and takes a long-term view of coastal zones. ICZM attempts to balance the needs of development with protection of the very resources that sustain coastal economies. It also takes into account the public's concern about the deteriorating environmental, socio-economic and cultural state of the European coastline.

The EEA intends to contribute to the review by promoting spatial analysis and enhancing the

integration of relevant environmental data with related socio-economical data, as far as current available information allows.

At the same time, this report aligns itself to the wider framework of ecosystems and human well-being set up by the Millennium Ecosystem Assessment (MEA, 2005a). By linking ecosystems and human well-being this approach focuses in particular on 'ecosystem services', i.e. the benefits people obtain from ecosystems. Every person depends on the services continuously supplied by ecosystems. Services are delivered both by 'near-natural' ecosystems, such as grasslands, seas and forests, and by highly managed ecosystems, such as cultivated or urban landscapes.

The conceptual framework of Millennium Ecosystem Assessment posits that people are integral parts of ecosystems. Dynamic interaction exists between them and other parts of the ecosystem. Furthermore, changing human conditions drive both directly and indirectly changes in ecosystems and thereby cause changes in human well-being.

The report serves the purpose of developing the EEA's approach to spatial integrated assessment. The aim is to understand spatial changes in coastal systems, tackle the biodiversity loss, and at the same time serve as a first baseline for monitoring progress of sustainable development along the coasts. The report intends to assess what is happening in the coastal areas of Europe and the current state of the coasts. By doing this, it shows as much as possible the specificity of the coast in relation to the rest of the territory, makes the coast more visible for the public and provides policy focus.

Throughout this report a European view is taken which focuses on a majority number of coastal countries in Europe. The number of coastal countries analysed may change in relation to each topic depending on the availability of data. For example, 17 coastal countries are covered by Corine land cover data for both 1990 and 2000, whereas Eurostat data covers 20 countries (18 countries for population trends analysis). Moreover, country case studies and regional examples are used where

relevant. Unfortunately, lack of more up to date and comparable baseline data does not allow systematic analysis of recent 2000–2005 trends in land cover of coastal zones. An overview of the European spatial data sources available for this report is provided in the annex.

The coastal zone in this report is interpreted as the resulting environment from the coexistence of two margins: coastal land defined as the terrestrial edge of continents, and coastal waters defined as the littoral section of shelf seas. Together they constitute a whole, which needs a specific methodological approach and dedicated management methods.

In this report, coastlines are determined from the Corine land cover data base (CLC). The terrestrial portion of the coastal zone is defined by an area extending 10 km landwards from the coastline. Where relevant, assessment of the basic coastal zone is enhanced by comparisons between the immediate coastal strip (up to 1 km), the coastal hinterland (coastal zone between 1 and 10 kilometre line) and the non-coastal national territory, called inland. The marine part of coastal zone is defined as a zone extending 10 km offshore (i.e. as in Natura2000 coverage analysis) or a variable zone of shelf sea depending on the issue analysed (e.g. navigation routes, territorial waters, fisheries, coastal dynamics). The generic term used throughout the report is coastal zone, but coastal area, coast, coastal space and coastal systems are used synonymously to better accommodate the particular context.

Depending on the coastline data and definition of the coastal zone used, the estimates of European terrestrial coastal zone can vary between 4 and 13 % of the land mass. In line with the above definition and based on CLC data, there is almost 185 000 km of coastline and 560 000 km² of coastal zones (terrestrial part) in the 24 European coastal countries available for this measurement (20 coastal EU Member States plus Norway, Iceland, Bulgaria and Romania) (see Annex). This area corresponds to 13 % of the total land mass of these countries, and 11 %, if only 20 coastal EU countries are included.

Comparison to the global value, which was based on a different definition of the coastal zone extent (area up to 50 m elevation or 100 km from the shore), shows Europe's share of terrestrial coastal zones broadly matching the world's average 4.1 % (MEA, 2005a). Estimates for the whole of the EU

may also be different from presented numbers. According to DG Joint Research Centre (Carreau and Gallego, 2006), the area of 0–10 km terrestrial coastal zone of EU-25 is 378 000 km² (9.4 % of EU-25 total territory).

Regional analysis of European coastal land area shows that this resource is distributed rather unevenly. Two countries are almost landlocked (having just a single sea port), nine include less than 1 % of European coasts and nine countries (Norway, the United Kingdom, Finland, Greece, Italy, Spain, Denmark, Sweden and France) represent approximately 80 % of Europe's coasts.

A regional perspective on the state of the coastal zones also requires the diverse conditions, problems and needs of European marine environment to be taken into account. Based on the ecosystem approach, the EU's marine strategy ⁽¹⁾ proposes a framework of marine regions and sub-regions. The current proposal for the marine strategy directive presents the vision of three Marine regions (the Baltic Sea, the North-East Atlantic Ocean and the Mediterranean Sea) which can be divided into sub-regions.

Such regionalisation of integral European marine waters also facilitates integrated coastal management and provides grounds for assessment of regional seas' coastal zones. The regional approach proposed by the EU's marine strategy broadly corresponds to the UN definition of large marine ecosystems in Europe ⁽²⁾. However, this report presents the trends at the Europe's coastal zones by aggregating them for the Baltic, the North Sea, North-East Atlantic Ocean, the Mediterranean Sea and, for a degree possible, the Black Sea.

1.1.1 State of coasts in Europe: main trends and relevance to policies

Coastal ecosystems — coastal lands, areas of transitional waters, and near shore marine areas — are among the most productive yet highly threatened systems in the world. Between 1990 and 2000, Europe lost more coastal wetlands despite an already high wetland conversion rate during the previous decades. However, the first signs of relief are emerging with the new concept of 'managed realignment', which returns some coastal space to its natural state. Other valuable ecosystems, such as coastal dunes and sea grass beds remain continuously under threat.

⁽¹⁾ <http://ec.europa.eu/environment/water/marine.htm> — accessed 06/06/2006.

⁽²⁾ www.oceansatlas.org — accessed 06/06/2006.

Population densities along European coasts are higher and continue to grow faster than those inland. However, differences are less pronounced in Europe than the rest of the world. Populations tend to be concentrated in certain areas, most favourable for trade, marine industry or recreation. These areas are often the location of the most valuable coastal ecosystems (e.g. Mediterranean).

There is widespread evidence that European coasts are a natural environment that attract socio-economic development due to a range of reasons. This attractiveness introduces multiple factors related to changing land uses, which can lead to increased stress on both natural and human environments. The development-related loss of coastal systems, habitats and services has caused the most notable changes to coastal zones.

Between 1990 and 2000, artificial surfaces in coastal zones increased in almost all European countries. Economic restructuring has been a driver for infrastructure development, which in turn has attracted residential sprawl. The highest increase in artificial surfaces (20–35 %) has been observed in the coastal zones of Portugal, Ireland and Spain.

At European level, more than 2 720 km² of agricultural land (especially mixed agriculture and pasture) and semi-natural and natural land were lost predominantly to artificial surfaces during this period.

Human pressures on coastal resources can compromise ecosystem integrity. Recent patterns of over-exploitation of key fish stocks in European regional seas have altered the structure of marine ecosystems. Other examples, involving increasing sand and gravel extraction for construction or beach nourishment, has the potential to disturb the sediment balance around a European coast already influenced by sediment trapping of river dams. Potential threats from emerging off-shore wind energy installations need careful planning, too.

There is growing evidence that Europe's coastal systems (including marine and terrestrial) are suffering widespread and significant degradation (e.g. loss of habitat, eutrophication, contamination, erosion, alien species). This poses a major challenge to policy makers and coastal managers. Land based sources of pollutants, but also other indirect sources, play an important role in the formation of coastal pressures. Therefore linking coastal zones with river basins is a priority.

Physical space (land and sea) is also a key resource that is needed to produce or sustain other natural

resources and some ecosystem services. Within this interpretation the coastal zone is a 'finite resource'; 'finite' due to its limited spatial extent as a narrow band along the coastline which is subject to on-going land conversion for industrial and urban use. The 'resource' of coastal space is also threatened due to the widespread prioritisation of short-term economic interest at the expense of regulating and provisioning services that could be permanently lost.

People like to live by the sea because of arguably a better quality of life. This fact may be expressed in elevated real estate prices. But current land use and economic practices often expose coastal populations to threats such as coastal flooding and erosion. These risks may severely compromise relatively high levels of human well-being on the coast, and underline the role for ICZM in reducing these vulnerabilities.

Coasts can support only a certain amount of activity without suffering environmental degradation. Due to the gradual expansion of different human activities, coastal zones have accommodated a number of different uses. Often these human activities lack long-term coordinated spatial planning. These activities also affect marine areas. Consequently, unregulated growth has led to mixed land-use and large scale fragmentation of open space (Belpaeme and Konings, 2004).

In response to this, the EU has been designating extensive coastal sites through its Natura2000 network (both on land and sea) to protect the coast from further development. For the EU-15 Member States, more than 70 % of coastal regional units (NUTS3) have at least one Natura2000 site. In total Natura2000 sites cover more than 50 000 km², approximately 15 % of the coastal zone (landwards and seawards). More than 40 % of the total area covered by coastal Natura2000 sites is represented by habitats of European interest (habitat's directive Annex I).

The state of the coast is often described through the management of coasts on local, regional and national scales. However, coastal issues are also recognised to be of relevance on a European scale, because often they cannot be solved by the Member States separately (e.g. common natural and cultural heritage, transfers of pollutants and sediments, tourist flows or maritime safety).

Typically, management responsibilities with respect to coastal areas are spread across several levels of administration. ICZM is a process that implies a new style of governance that is in partnership with all of the segments of civil society. However, this

collaboration must go beyond the involvement of the stakeholders who are physically present in the narrow coastal strip. As many of the problems facing coastal zones can only be solved through a much broader integrated approach, many actors from elsewhere in the same marine region, river basin or other parts of the hinterland must also be involved.

However, concrete integration actions usually occur at local level, in the context of detailed planning, problem solving and territorial management. Regional level of government provides support to this by ensuring the integrated planning and co-ordination between local municipalities in the larger regional context. The effective administration of coastal zones becomes a key factor for achieving long-term development goals. The important condition for that is adoption of governance mechanisms taking into account the territorial integrated vision of the coasts.

1.1.2 Policy responses: from conceptual framework towards integrated spatial management

Europe has a wide diversity of coastal landscapes configuring a complex territory with regards to different aspects of environmental, social, cultural and economic conditions.

There is a challenge to provide human safety and promote economic development without compromising ecological integrity. Although ecosystems contribute to human well-being, these services are often not quantified and therefore the benefits are not recognised in management. This issue is exacerbated by a lack of knowledge of the contribution of ecosystems to human welfare, such as the ability of salt marshes to reduce wave energy in coastal systems and their potential role as a natural buffer (Rochelle-Newall *et al.*, 2005).

The Commission's communication on ICZM Strategy for Europe (COM(2000)547) asks for integrated management of the coastal zone that requires action at local and regional level. This is guided and supported by a national vision and appropriate framework on a national level. The EU should support these actions through the generation of factual information and knowledge about the coastal zone by defining indicators for the coastal zone. These indicators would also serve as examples for more widespread adoption of integrated territorial management principles across Europe.

The EU's ICZM Recommendation can be seen as a first step in the implementation of the vision outlined by the strategy. Along with setting the

fundamental principles of sound coastal zone development, it calls on Member States to carry out national stocktaking and prepare national strategies for coastal zones. In addition, an activity to create indicators for monitoring the implementation of these coming strategies has been initiated.

Despite general recognition of the need for regional sustainable development, existing environmental policies do not sufficiently address the spatial and complex nature of coastal zones, and only a few policies facilitate the emergence of a common conceptual framework for coasts. For example, the European Spatial Development Perspective (see European Commission, 1999a) — a major EU policy initiative to promote spatial planning and horizontal dimension of sustainable development — has not counter-balanced the development pressure from key economic sectors, such as tourism and transport infrastructure.

At the same time, coastal waters are recognised by the water framework directive as an integrated part of river basin management districts. The European marine thematic strategy also addresses the coasts by promoting an ecosystem-based approach and proposing marine regions.

Hopefully, the increasing attention to the coastal zones will result in the development of an efficient and ambitious integrated maritime policy in the future. The Green Paper on an EU Maritime Policy gives direction for the integrated management of the sea and the coast within the spirit of sustainable development.

All these new policy developments are expected to create demand for the integrated spatial assessment of coasts. This is essential for creating a knowledge base for better regional management of coastal systems at the land and water interface.

1.1.3 Coastal conflicts: towards a human perspective

The methodology used in this report specifically addresses the spatial analysis of overlapping interests on the coast. As a principle, these contradictory forces should be kept at a level which does not lead to unwanted environmental stress. However, this involves a subjective assessment of the different uses of the coast. These subjective views represent the values of people living by the sea and need to be balanced against each other and the views derived from outside coastal zones. To provide an adequate answer, future work has also to deal with the life of coastal communities. This work

should take a closer look at how a local population tackles local development and environmental issues, and how they adapt to specific coastal situations.

Another key challenge from a human perspective is vulnerability and adaptation to climate change, especially with regard to sea level rise. This topic, addressed as a transversal issue across the sections of this report, is tackled via the human dimension.

1.2 Scope

This report looks at the EU's coasts in the context of sustainable development, focusing on environmental aspects as an entry point. Coastal integration is also taken into account by an approach to ecosystem analysis of land, water and biodiversity characterised by a spatial perspective.

For the assessment of the environmental state of European coasts, two underpinning activities are addressed:

- the spatial analysis of the state of coasts as a result of changes in land cover and land use. This is linked to the development of different

policies, e.g. tourism, physical planning, agriculture, nature protection;

- the collecting and analysis of stakeholders' views and opinions on the analytical approach and the results.

The focus of the report is mainly on the land/sea interface. Marine ecosystems and offshore environments are addressed where relevant and where adequate data exist. However, the report does not cover Europe's ultra-peripheral regions, such as small islands.

1.3 Structure

Chapter two presents a factual description of the current trends in the state of the coasts. This is followed in chapters three and four by a synthesis of the integrated spatial assessment and current trends in policies relevant to the coastal zones. The concluding chapter discusses the need for a conceptual framework for the management of coasts, and summarises lessons learnt and future development perspectives. The annex presents all data issues and an overview of the methodological development that forms the basis of this report.

2 Trends in state of coasts: facts and figures

2.1 Main changes in land cover and population

For the 17 coastal countries covered by Corine land cover change analyses, three main types of coastal land use trends occurred between 1990 and 2000: artificial surfaces increased during the period by almost 1 900 km², pasture and mixed farmland showed a major decrease (1 230 km²) and arable

lands and permanent crops increased (713 km²). However, there were significant differences in land cover change patterns between various countries and at regional level.

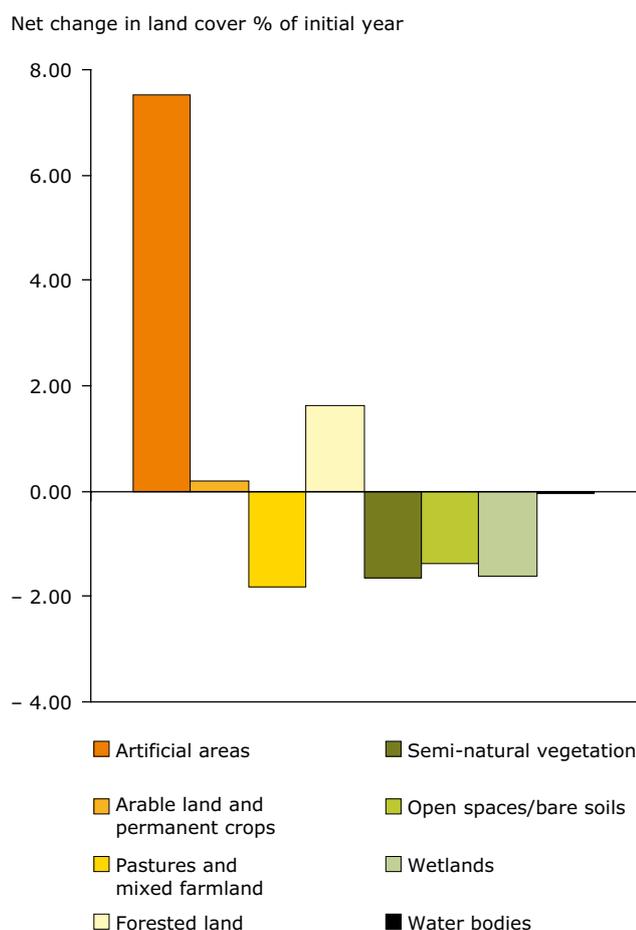
In 2000 the share of area covered by artificial surfaces was 25 % higher on the coast than inland. During 1990–2000, trends in the European coastal zone showed that the growth rate of artificial surfaces was about 1/3 faster than inland (for the definitions of coastal zones see introduction).

In tandem, growth of urban artificial surfaces in the coastal zones of Europe has continued. On the basis of the annual growth rates observed during 1990–2000, it is projected that by 2004 the 1990 levels will have been exceeded by 12 %. The fastest development has taken place in Portugal (34 %), Ireland (27 %), Spain (18 %), followed by France, Italy and Greece. The most affected regional coasts is the western Mediterranean.

Within the 10 km coastal zone, urban surfaces are dominant on the first kilometre from the shoreline. In several coastal regions of Italy, France and Spain the coverage of built-up areas in the first kilometre coastal strip exceeds 45 %. In these areas further development is occurring in the coastal hinterland.

Population densities are also higher on the coast than inland. For Europe, population densities of the coastal regions (NUTS3) are on average 10 % higher than inland. However, in some countries this figure can be more than 50 %. There are many regions where the coastal population is at least five times the European average density. Calculated from redistributed population values for the 0–10 km coastal zone, population densities on the coast are twice as big as total population densities of EU-25 countries (Gallego, 2006). Unfortunately, the lack of data availability precludes a systematic analysis of seasonal population sizes on European coasts. However, it is obvious that most coasts experience significant seasonal peaks which in some areas overshadow the permanent population. The case study from Costa Brava (Girona, Spain), showed that in an average year the total seasonal

Figure 1 Land cover change within the 10 km coastal zone of 17 of European countries (1990–2000)



Note: Countries included are: 20 EU coastal Member States (with the exception of Cyprus, Finland, Malta, Sweden and the United Kingdom), Bulgaria and Romania.

Source: EEA, 2005.

population reached 2.6 visitors per resident (Sarda *et al.*, 2005).

However, European coasts are very diverse. There are also many coastal regions (NUTS3) where population density is five times less than average and continues to decrease (see Map 1). Higher densities are in general found in southern Europe, while the lowest densities are more likely to be found in north Europe, with the exception of the North Sea coasts. In certain regions of the Mediterranean coast higher densities are registered (e.g. Barcelona), but there are also regions with low population densities such as Corsica, parts of Sardinia etc.

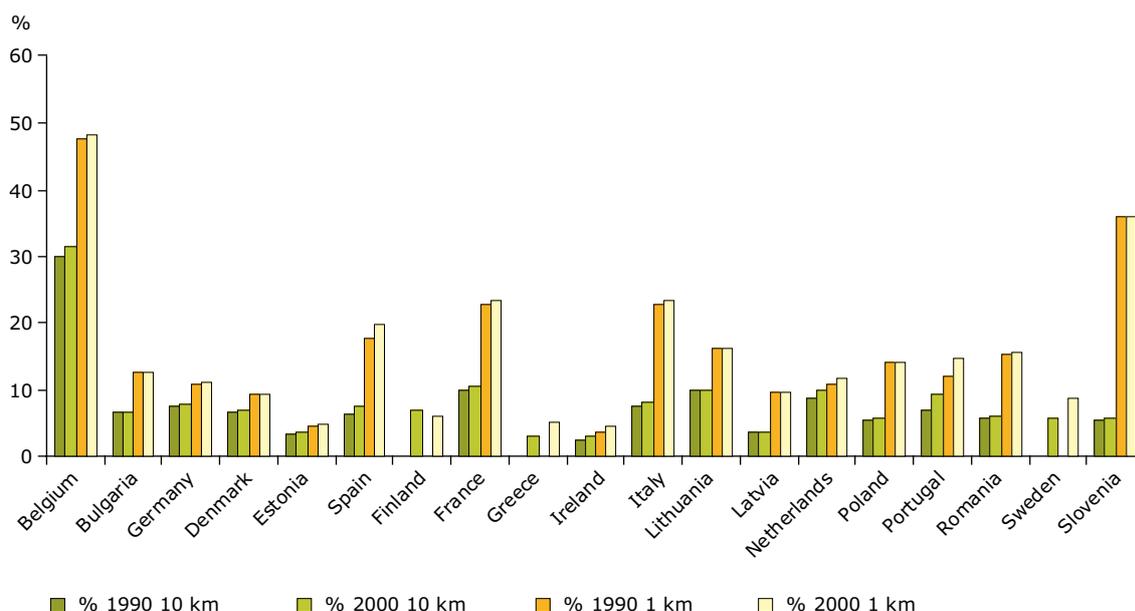
Depending on the definition of coastal zone extent (see Section 1.1), estimates of current (2001) coastal population may differ substantially. A widely published number originating from the EuroSION project ⁽³⁾ estimates the population living in coastal municipalities in the EU as being approximately 70 million people (16 % of the EU-25 population). However, estimates vary depending on the applied methodology. For example, DG Joint Research Centre (Carreau and Gallego, 2006) has estimated that the population living in the 0–10 km coastal zone is 86 million inhabitants (19 % of EU-25 total population). This estimate is based on the 2001 census data. Applying the coastal zone definition of

the Millennium Ecosystem Assessment is likely to produce yet another figure for coastal population size. The following analysis of coastal population dynamics in this report is, due to data availability reasons, based on the coastal population of coastal regions (NUTS3) rather than much smaller coastal municipalities or the 0–10 km coastal zone itself.

Population change analyses of 18 European coastal countries where population data 1991–2001 was available (EEA coastal member countries Bulgaria, Germany, Greece, Lithuania, Malta, Poland and Turkey not included) show that population continues to be concentrated in European coastal regions (NUTS3). According to the 2001 census, coastal regions of these 18 coastal countries had 140 million inhabitants. Since 1991 the coastal population has grown by 3.44 % (on average, almost 0.5 million per year), which is about 1/4 faster than the growth rate of the total population of these countries.

However, notable regional differences exist. Some countries, such as Estonia, Latvia, Romania and Italy lost coastal population between 1991 and 2001. This fact should be viewed against the general de-population trends of these countries (with the exception of Italy). In other countries the coastal population clearly increased, but at

Figure 2 Built-up area in the 0–1 km coastal strip versus the entire 10 km coastal zone (1990–2000)



Source: EEA, 2005.

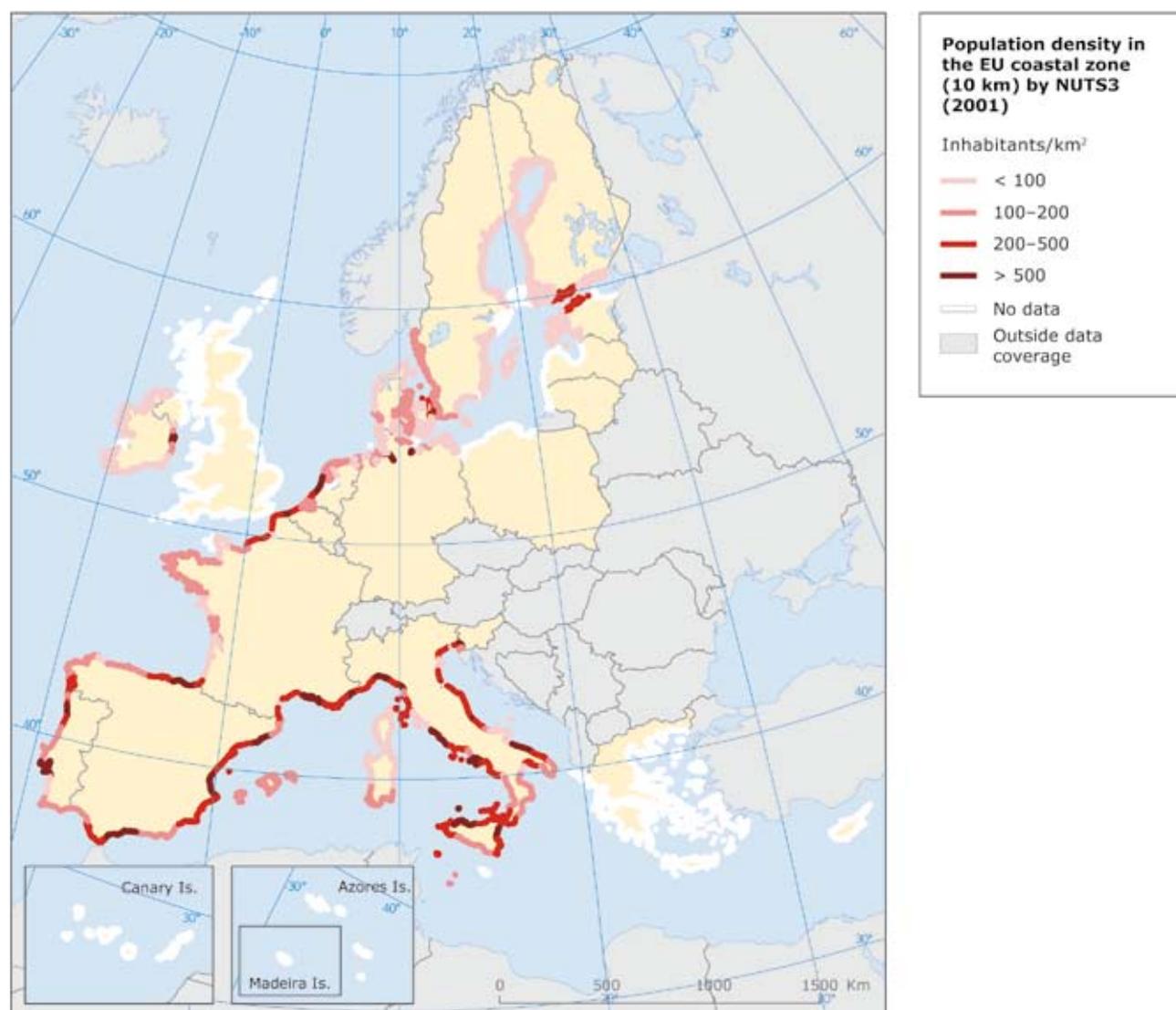
⁽³⁾ www.euroSION.org — accessed 17.03.2005.

a somewhat slower rate than total population (Belgium, Netherlands and the United Kingdom). One interpretation would be the saturation of North Sea coasts, which already had very high population densities. Regarding the coasts of European regional seas, population growth increased on most sea fronts between 1991 and 2001. The highest increases were registered on the Atlantic coast (6.4 %) (e.g. France, Ireland and Portugal). Even on the Nordic coast of the Baltic Sea, noticeable increases of population were registered (3.3 %), especially in some urban spots (e.g. Helsinki, southern regions of Sweden). Some growth still continues on the North Sea coasts (2.9 %). In the Mediterranean, significant increases were registered for some coastal regions of France and Spain. Assessed Black Sea coasts showed a population decrease (-1.6 %).

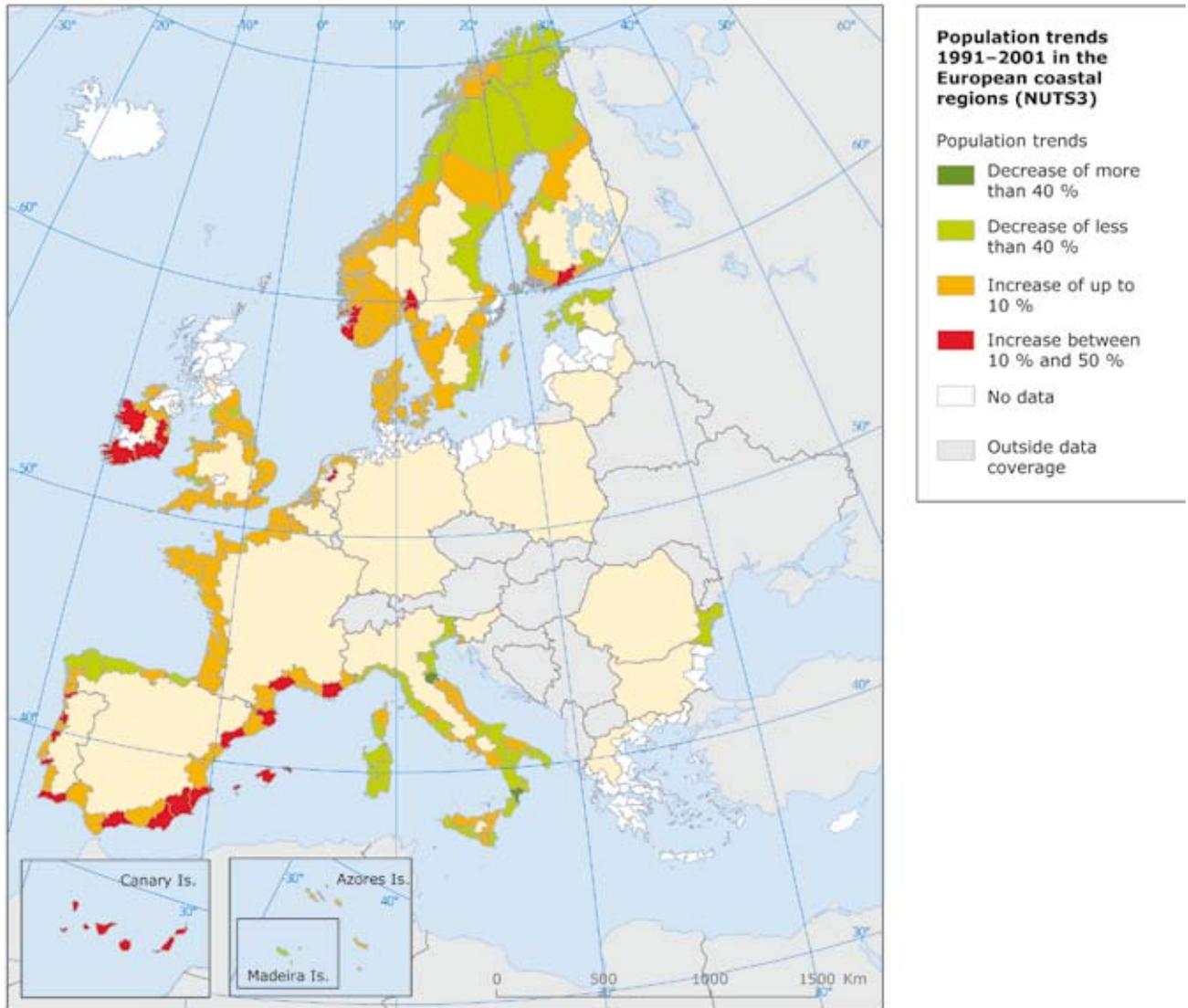
2.2 Coastal zones of regional seas' catchments

Regional seas have different coastal landscapes. Semi-natural and natural lowlands cover almost 25 % of the 10 km coastal zone of the North Sea and almost 20 % of the Baltic Sea. Upland, open semi-natural and natural landscapes are comparatively more extensive along the Black Sea and Mediterranean Sea. Lowland forests are important on the Atlantic coast, covering approximately 30 % of the coastal area. Lowland composite rural landscapes represent 20 % on the Baltic coastal zone and 10 % on the Mediterranean. The North Sea coast represents the highest percentage of dense, urban areas (20 %). Dispersed urban areas are more acute along the Mediterranean Sea (12 %) and the Atlantic coasts.

Map 1 Population density in the European coastal zone (0–10 km) in 2001



Source: EEA, 2005, based on population density disaggregated with CLC2000, JRC, 2005.

Map 2 Population trends between 1991 and 2001 in the European coastal regions

Source: EEA, 2005, based on population census 1991 and 2001, Eurostat.

During the last decade important land use and land cover changes have been observed in the 10 km coastal zone on the five European regional seas (17 countries). In general terms, the artificial surface and associated use of the coastal zone has grown intensively especially in the Mediterranean (804 km²), and the Atlantic (690 km²). The North Sea shows lower growth of artificial surfaces (235 km²), and the Baltic Sea (142 km²) and the Black Sea (11 km²) show the lowest value of change. However, in relation to the total area of the assessed coastal zone, the increase of artificial surfaces is almost 15 % in the Atlantic, 10 % in the Mediterranean Sea, 8 % in the North Sea and 5 % in the Baltic Sea. Changes to artificial surfaces and the Black Sea represent approximately 2.5 %. Gains in artificial surfaces

represent the highest individual land cover change in the coastal zones of regional sea catchments.

Transformation of land into artificial surface is most intensive in the first kilometre from the coastline. The percentage of built up areas in the first kilometre is 17 % for the North Sea coast (compared to 11 % for the whole 10 km coastal zone); 16 % compared to 6 % for the Mediterranean coast; 14 % compared to 6 % for the Black Sea; 12 % compared to 6 % for the Atlantic; and 9 % compared to 6 % for the Baltic Sea.

Important gains in arable land and permanent crops, i.e. intensification of agriculture (772 km²) is observed especially for the Atlantic, compared to

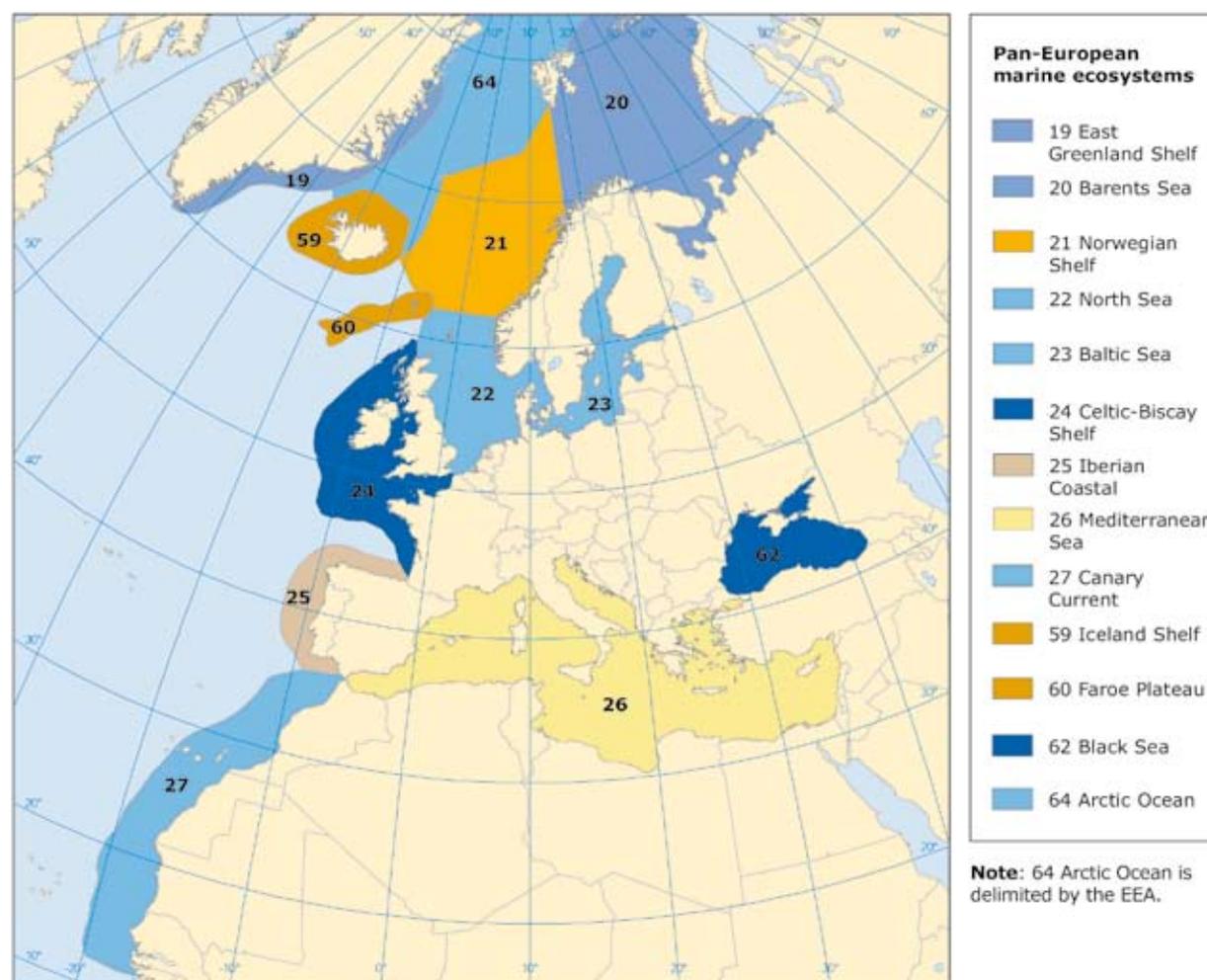
a general loss around the Baltic Sea (230 km²) and the Mediterranean (253 km²). For the North Sea, the figure remains the same.

Pastures and mixed farmland, natural and semi-natural open spaces, and wetlands show a major decrease, as they are transformed into intensive agriculture or into urban land cover categories in the Atlantic region, and in urban categories in the remainder of the regions. Loss of wetlands, natural grassland, natural and semi-natural vegetation, and pasture and mixed farmland is highest on the Atlantic coast. The loss of pasture and mixed farmland alone was 1 220 km². Almost all European losses of wetlands have occurred on the Atlantic coast, which lost nearly 5 % of its wetlands (422 km²). This figure is more than the overall 1990–2000 European negative balance, which is compensated by some

gains of wetlands in other countries. Loss of pasture and mixed farming land also registered losses during the decade on the Mediterranean (– 303 km²) and on the Baltic Sea coast (– 229 km²). These losses were generally replaced by intensive agriculture or land uses of artificial surfaces.

Another important aspect to take into account is the high concentration of Natura2000 sites on the European coast, especially in the North Sea (where around 20 % of these coastal sites are located). Moreover, on the North Sea, the Atlantic and the Mediterranean coasts Natura2000 sites that protect both land and sea cover more than 20 % of the coastline length. Here, available data clearly show that European coastal zones are potential conflict zones due to the high levels of urbanisation and protection. These potential conflicts arise

Map 3 Pan-European marine ecosystems



Note: The large marine ecosystems (LMEs) project was created in support of the global objectives of Chapter 17 of Agenda 21, as a follow-up to the 1992 United Nations Conference on Environment and Development (UNCED). Out of the 64 LME defined worldwide, 13 are pertinent to the European environment. Numbering used in the map follows the one used in the LME project.

Source: UN (See www.oceanatlas.org — accessed 12/10/2005).

Table 1 European regional seas – main figures

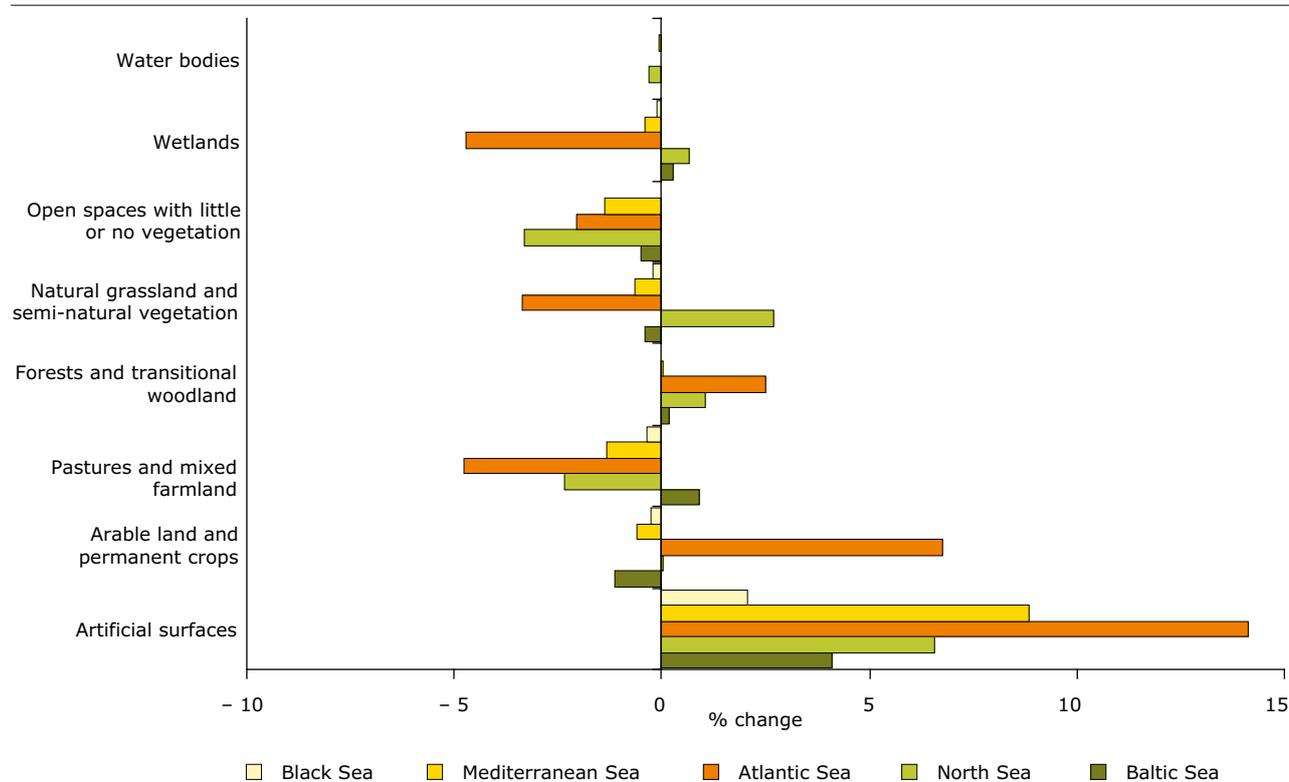
	Baltic Sea	North Sea	Atlantic Ocean (Celtic-Biscay Shelf and Iberian coastal sea)	Mediterranean Sea	Black Sea
Neighbouring EEA and collaborating countries	SE, FI, EE, LT, LV, PL, DE, DK	UK, NO, DK, DE, NL, BE, SE	IE, UK, FR, ES, PT	ES, FR, IT, SI, MT, HR, BA, CS, AL, EL, CY, TR	BG, RO, TR
Coastline, km (from Corine LC data)	75 298	35 696	46 306	51 471	8 603
Area of the 0–10 km zone, km² (from Corine LC data)	226 220	127 581	194 197	265 999	64 743
Sea surface area, km²	370 000	750 000	Not available	2 500 000	432 000
Water volume, km³	20 000	67 500	Not available	3 750 000	547 000
Average and max. depth, m	53 Max. 459	90 Max. 725	Not available Max. 5 800	1 500 Max. 5 267	1 300 Max. 2 210
Area of catchment, km²	1 700 000	850 000	830 000	1 900 000	2 000 000
Ratio of catchment area and sea volume	85	12	Not available	0.51	3.6
Total population of basin, million inhabitants	85	165	Approximately 80–100	450	160
Coastal zones highlight (0–10 km terrestrial coastal zone)	Comparatively lower and more equilibrated repartition of the built up in the coastal zone. Important trend of growth during last decade in the entire coastal zone. Medium levels of protection in terms of number of Natura2000 sites. Accretion trends in different parts of the Baltic Sea.	Highest level of urbanisation (17 % of the coastal zone). Highest armoring of the coast including defenses and harbours. Erosion problems important: 20 % of North Sea coast eroding. Highest level of protection in terms of number of Natura2000 sites.	Highest trends in growth of artificial surfaces and sprawling in the whole coastal zone. Highest trends of agriculture intensification. Coupled with highest trends in loss of semi- natural and natural land. Highest losses of mixed agriculture and pasture. Medium levels of protection in terms of number of Natura2000 sites.	High level of urbanisation (16 %) at the coast with high increase of built up areas during last decade, especially along coastline and sprawling in the entire coastal zone. High level of coastal defences creating the 'Med wall'. Loss of semi- natural and natural land. Lower levels of protection in term of number of Natura2000 sites. Longest stretch of coast affected by erosion (30 %).	Incipient increase of artificial surfaces, still low in the whole of coastal zone, but taking already high percentage in the first km coastal strip. Still an important presence of natural and semi-natural land, including the Danube delta — the biggest delta in Europe. Presence of erosion (13 % of coast length) but relatively low level of coastal defences.

Note: AL: Albania; BA: Bosnia-Herzegovina; BE: Belgium; BG: Bulgaria; CS: Serbia and Montenegro; CY: Cyprus; DK: Denmark; DE: Germany; EE: Estonia; EL: Greece; ES: Spain; FI: Finland; FR: France; HR: Croatia; IE: Ireland; IT: Italy; LT: Lithuania; LV: Latvia; MT: Malta; NO: Norway; NL: Netherlands; PL: Poland; PT: Portugal; RO: Romania; SE: Sweden; SI: Slovenia; TR: Turkey; UK: United Kingdom.

Atlantic Ocean defined as Pan-European Marine Ecosystems no 24 and 25 (Celtic-Biscay Shelf Sea and Iberian coastal sea, respectively), the Black Sea includes the Azov Sea.

Source: The Black Sea Commission (www.blacksea-commission.org/main.htm), the Helsinki Commission (www.helcom.fi/environment2/nature/en_GB/nature), the OSPAR Commission (www.ospar.org/eng/html/welcome.html), the North Sea Commission (www.northsea.org), UNEP Mediterranean Action Plan (www.unepmap.org/home.asp), the Large Marine Ecosystems of the World (www.oceansatlas.org), and other weblinks; and EEA/UNEP, 2006.

Figure 3 Land cover changes in 0–10 km coastal zone of European regional seas (1990–2000)



Note: Countries included are: 20 EU coastal Member States (with the exception of Cyprus, Finland, Malta, Sweden and the United Kingdom), Bulgaria and Romania.

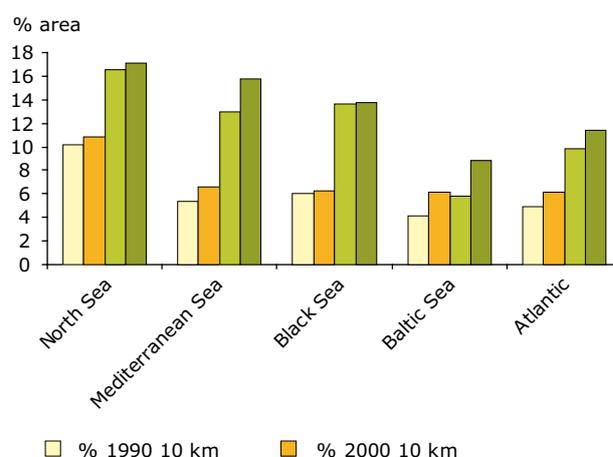
Source: EEA, 2005.

from intensive utilisation of coastal space by socio-economic activities (e.g. tourism, harbours).

Another worrying environmental problem is the high level of armoring of the shorelines by coastal defences and harbours. This is especially important in the North Sea (16 %) and along the Mediterranean coast (more than 8 %) where on average the conversion of the coastline into artificial areas (e.g. harbours, artificial beaches and other artificial constructions such as dams or sea walls) is very high. The coastal armoring should not be seen as a local solution and in isolation from other related issues because it is closely related to the important coastal erosion process affecting the stability of coasts of the whole region. The coastlines of the Mediterranean Sea (almost 30 %), the North Sea (20 %) and the Black Sea (13 %) have the most critical erosion hotspots.

Intensive human use of coasts and the overall increase in offshore activities in regional sea areas have impacted on water quality parameters and marine biodiversity. The main issues for each regional sea are described below:

Figure 4 Change of built-up areas in the 0–10 km and 0–1 km coastal zones



Note: Countries included are: 20 EU coastal Member States (with the exception of Cyprus, Finland, Malta, Sweden and the United Kingdom), Bulgaria and Romania.

Source: EEA, 2005.

Baltic Sea

- All environmental problems in the region are exacerbated by low salinity and slow renewal in this unusually shallow sea. A recent meeting of Nordic environmental ministers (23 November 2005) called for the Baltic Sea to be made a 'pilot project' under the newly drafted EU marine environment strategy.
- Eutrophication has caused increased amounts of planktonic algae, increased frequencies of toxic blooms of algae, the reduction of oxygen levels in the deep waters of the Baltic Sea and a decline or disappearance of larger perennial macroalgae.
- Fishing of the main target fish species such as cod, herring, salmon and eel is presently unsustainable due to over-exploitation and impairment of conditions for reproduction. Bycatches of marine mammals, seabirds and non-target fish species are also too high.
- The intensity of shipping activities and related environmental impacts have increased very rapidly over the last decade and are expected to increase considerably in the future. According to Helcom, there are around 2 000 ships at sea any one moment in time, accounting for 15 % of the world's cargo transportation. Every day 150–200 large tankers filled with oil are harboured in 20 ports around the Baltic Sea. By 2015 oil transportation is forecast to increase by a further 40 % to 160 million tonnes a year (Helcom ⁽⁴⁾).
- Pollution by organic contaminants have caused health and reproduction problems in marine mammals and birds. Oil has killed seabirds and negatively affected benthic communities.
- Changes in the structure and components of the ecosystem are caused by introduced species. Intentional introduction, fouling and ballast water are three important ways organisms have been introduced into the Baltic Sea. The river connections with the brackish waters in the Black and Caspian Seas increase the risk of introduction into a very vulnerable semi-closed sea.
- Special problems exist which originate from non-EU countries with different policies. For example, the pollution of the Pregolya river in Kaliningrad, the potential threat from Kratsovskoye oilfield and the D6 offshore platform (22 km from Kaliningrad coast).

North Sea

- One of the major environmental problems in this region is its colonisation by new species from the Atlantic.

- The strong coupling between benthic and pelagic communities in the shallow parts of the sea makes it extremely biologically productive. In fact, it is one of the most productive areas in the world, with a wide range of plankton, fish, seabirds and benthic communities.
- The North Sea is one of the world's most important fishing grounds, and the sea bed is also rich in oil and gas. All these resources are intensively exploited.
- Anthropogenic impacts have been significant for many years. The marine ecosystems are under intense pressure from fishing, nitrogen input (from air and rivers), recreational use and habitat loss. Most notable are the effects of fisheries and eutrophication. Until the mid 1990s pollution was the main issue at North Sea conferences. Over the last decade, there has been an increasing awareness and concern for the impaired status of several of the North Sea's commercially important fish stocks, as well as the impact of fisheries on other parts of the ecosystem.
- North Sea coasts have high economic and population concentrations and are most vulnerable to coastal zone flooding. Resulting inundations may become additional sources of pollution for the sea.

Atlantic

- The Atlantic coastal sea is a part of the North-East Atlantic Ocean and is dominated by deep ocean basins, with the exception of the Celtic Sea, the shelf along the Bay of Biscay and the Iberian coast.
- The formation of North Atlantic deep water is one of the driving forces for the thermohaline circulation of the world's oceans. The primary productivity in the open ocean is low, but is increasing from south to north and towards shore.
- Biodiversity is high, but several species in the area are endangered. A lack of sustainable fishery management is probably the most important threat here.
- The main actual and potential threats to marine habitats and biodiversity in the North-East Atlantic are the:
 - lack of sustainable regulation of fisheries, e.g. over fishing, bottom trawling, discards, catch of non-targeted species etc.;
 - pollution from maritime transport due to oil spills and TBT in antifouling paints.
- There is a shortage of information and/or monitoring on species, habitats and fish stocks in

⁽⁴⁾ www.helcom.fi — accessed 16.05.2006.

the North-East Atlantic Ocean, except for coastal waters. The effects of global warming and any changes in ocean circulation are critical for marine and coastal ecosystems.

- The North-East Atlantic Ocean is protected by the OSPAR convention and other more global conventions. Nature protection is primarily focused on coastal areas and is still poor in other parts of the ocean, e.g. sea mounts.

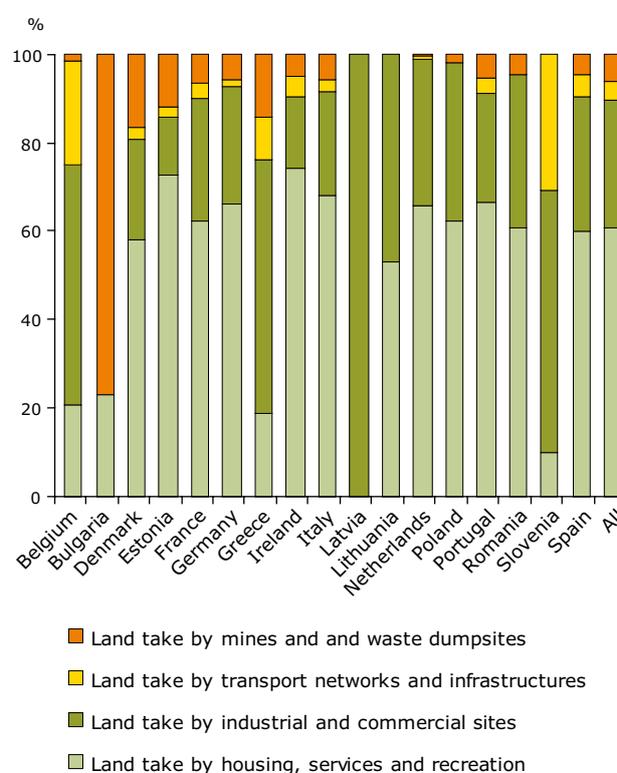
Mediterranean Sea

- The Mediterranean Sea is oligotrophic. It is rich in oxygen and poor in nutrients. Oligotrophic conditions increase from west to east.
- The fauna and flora is one of the richest in the world in terms of species diversity and there is a high rate of endemism. Compared to the Atlantic, the Mediterranean marine communities have many different species with generally smaller individual specimens (Mediterranean nanism).
- Eutrophication in coastal areas has almost certainly resulted in an increase in fish catches of some pelagic fish species in the formerly low-nutrient waters of the Mediterranean Sea. However, fishing has resulted in over-exploitation of several fish stocks in the Mediterranean.
- The immuno-suppressive effects of contaminants arising from agriculture, industrial activity and population growth may have contributed to the severity of mass mortalities among marine mammals in the Mediterranean Sea. Toxic algal blooms have become more frequent.
- Fishery by-catches of marine wildlife pose a threat to their populations. For example, mortality of the monk seal is mostly associated with fishing. Over-exploitation by intensive collection has led to a serious decline in some corals and many shellfish.
- Introduction of alien species through ballast waters, fouling, import and invasion has resulted in the establishment of dense natural populations of species. Introduced alien species are increasing in the Eastern basin. The impact of some intruders like the tropical algae *Caulerpa taxifolia* has had catastrophic effects on the natural environment.
- High development rates of some West-Mediterranean coasts have made them increasingly vulnerable to coastal erosion risks.

Black Sea

- Nearly 87 % of the Black Sea is entirely anoxic (without oxygen) and contains high levels of hydrogen sulphide. This is the result of past geological events, the characteristics and shape

Figure 5 Land take by urban development in 0–10 km coastal zone (1990–2000)



Source: EEA, 2005.

of basin, its specific water balance and a high degree of isolation from the world's oceans.

- The composition and structure of the marine communities are constantly changing with the decline of certain species and the expansion of others. However, deep pelagic and benthic organisms are largely absent, and in the undisturbed conditions species diversity in Black Sea fauna is approximately three times less than that in the Mediterranean.
- Increasing salinity due to inappropriate water management and regulation, and pollution of brackish coastal lakes and estuaries represents a threat to coastal wetlands, relics and endemic species, especially in the Sea of Azov.
- As a result of eutrophication, primary production has increased and the number of species has declined. These changes, as well as inappropriate fishing practices, have affected fish stocks. A change towards small pelagic fish, i.e. anchovy and sprat, has been observed. This can be regarded as fishing down the food chain.
- The rich diversity of biotopes creates favourable conditions for invasion by alien species to the Black Sea. Deterioration of some marine habitats and over-exploitation of fish stocks

has left the ecosystem vulnerable to invasion by such species, for example via ballast waters. For example, the invasion of the comb jellyfish (*Mnemiopsis leidyi*) led to the emergence of huge populations, which changed the equilibrium of the native marine ecosystem. This caused the collapse of anchovy fish stocks in the Black Sea and the disappearance of the most valuable fish species. There is no overall management of fish stocks in place in the Black Sea.

The seas and coasts around Europe are a vital resource upon which many millions of people depend on both economically and for leisure. They also provide a wide range of ecosystems services that are essential to the health of Europe's environment.

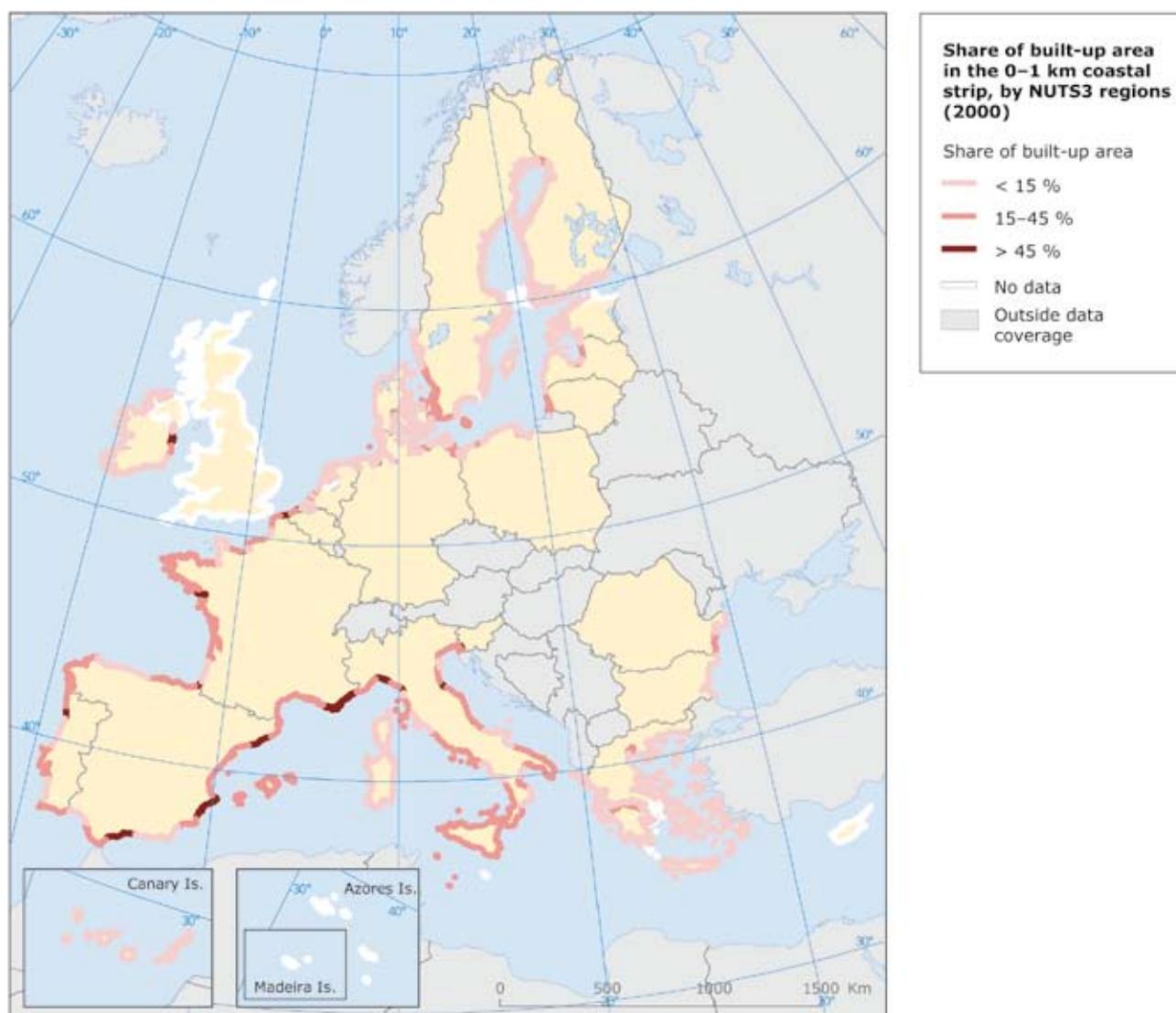
Different seas face both common and unique interconnected challenges, highlighting the value of integrated approaches to solutions.

2.3 Artificial surfaces

Artificial surfaces spread by 190 km² per year between 1990–2000. Due to the irreversible nature of land cover change from natural to urban and infrastructure development, these changes are seen as one of the main threats to the sustainability of coastal zones.

61 % of total land uptake by artificial surfaces was due to housing, services and recreation. Industrial and commercial sites also took up land (see Figure 5).

Map 4 Share of built-up area in the 0–1 km coastal strip, by NUTS3 (2000)

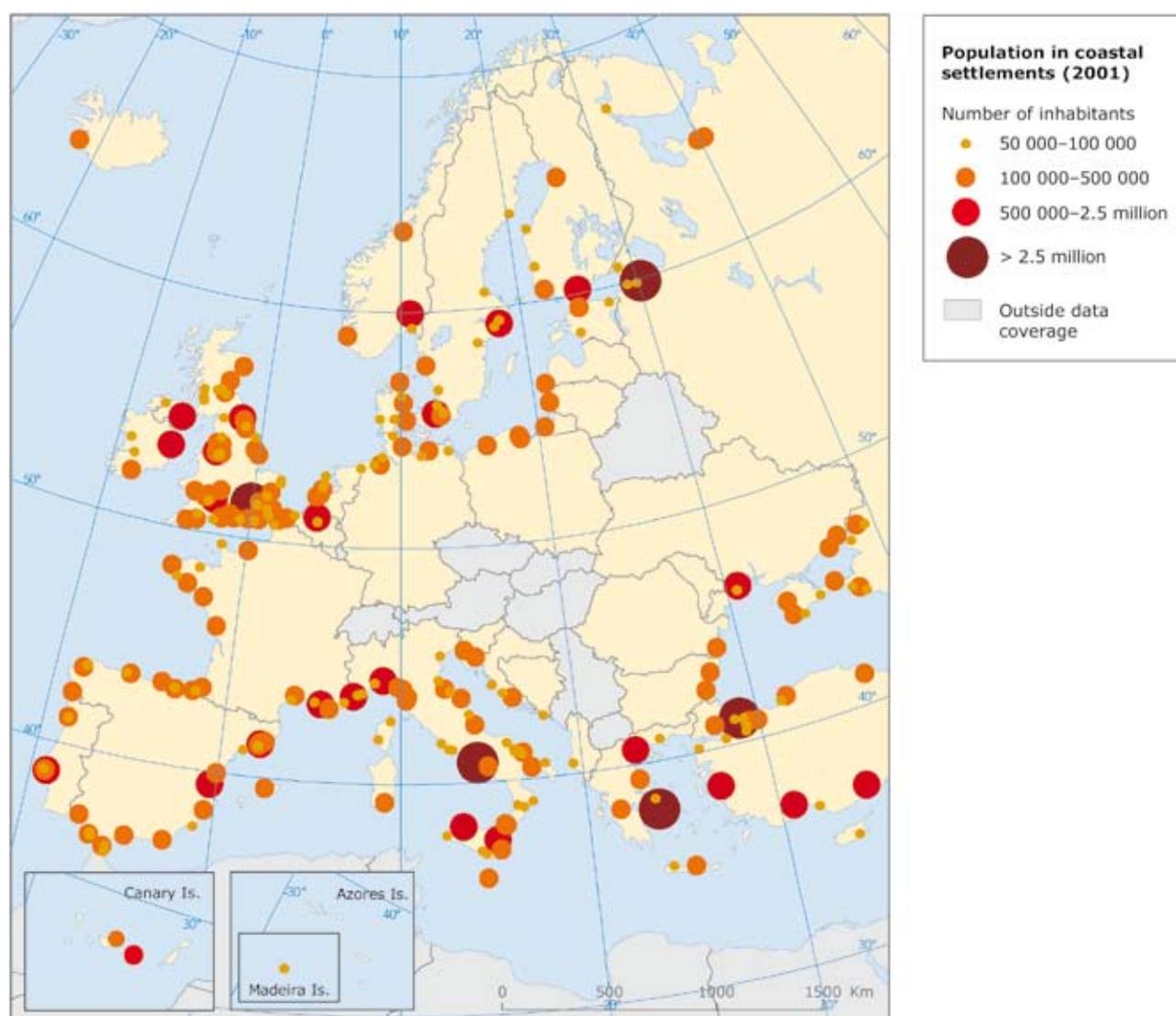


Source: EEA, 2005, based on Corine land cover, 2000.

Table 2 Number of settlements with > 50 000 inhabitants per 100 km of coastline

Clusters of ratio (see title)	Countries	Type of settlement density pattern
< 0.05	Iceland, Norway	Extremely low settlement density of North Atlantic coasts
0.15–0.35	Greece, Ireland, Latvia, Cyprus, Finland, Denmark, Sweden, Estonia	Typical low settlement density on European peripheral coasts
0.40–0.50	Romania, Portugal	Increased low settlement density on European peripheral coasts
0.60–0.70	France, Germany, Poland, Bulgaria	First tier high settlement density of intensively occupied coasts
0.75–1.00	The United Kingdom, Italy, Spain, Netherlands	Typical high settlement density of intensively occupied coasts
> 1.5	Lithuania, Belgium, Malta	Extremely high settlement density of short developed coastlines

Note: Density for the whole European coastal zone is 0.43, which is influenced by extremely low values for Iceland and Norway. Without these countries the average density of settlements would be 0.57.

Map 5 Population in coastal settlements (2001)

Source: EEA, 2005, based on GISCO, 2000.

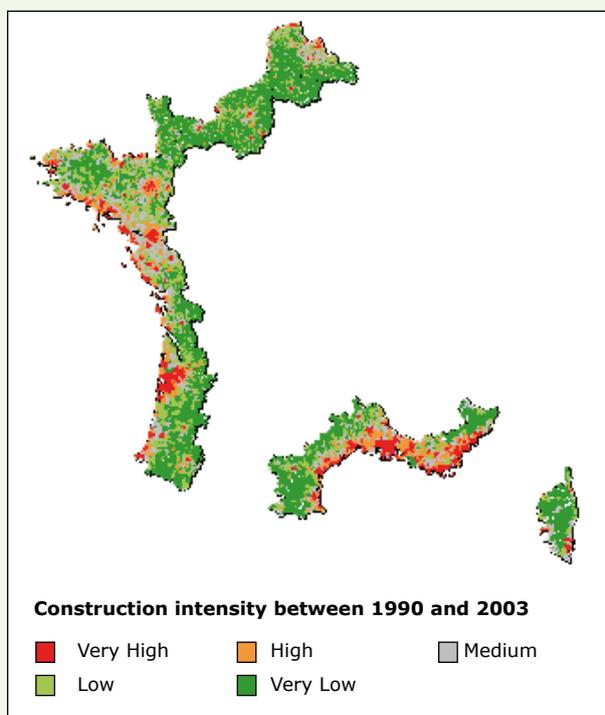
Closer examination of internal differences within coastal zones shows that urban surfaces are more concentrated within the first kilometre of the coastline. In some countries they represent up to

45 % of the area. Therefore, the immediate coastal strip (i.e. the first kilometre from the coastline landwards) receives most pressures. These pressures are especially intense in some coastal areas, such

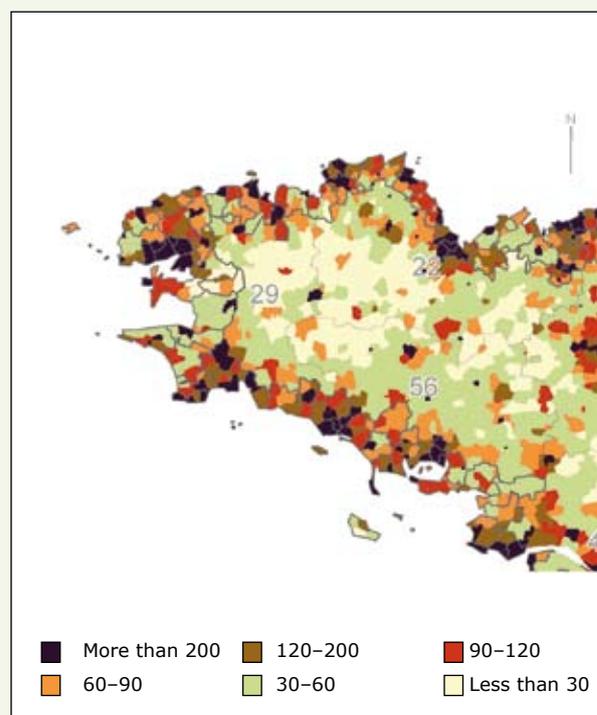
Box 1 Coastal development patterns – case study (France)

Development pressure continues to be very significant on the Mediterranean coast despite the fact that the degree of occupation is already very high. This finding is based on construction permits granted by French planning authorities between 1990 and 2003. Pressures are also being felt on the Atlantic coast, due to construction, especially the coast of Brittany (see inset). Moreover, trends show that new construction is spreading farther away from the coastline, provoking a shift of occupation towards second and third development areas along the coasts.

Construction of housings between 1990 and 2003 in the French coastal NUTS3



Population density in Brittany, France. Inhabitants per km² by NUTS5 in 1999



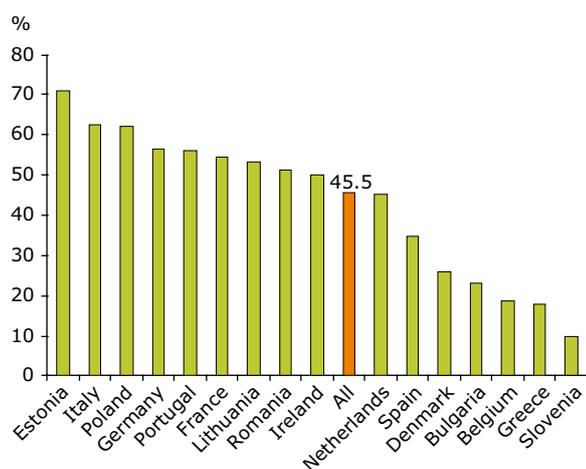
This urban trend correlates with a social shift. The near coastline is reserved for seasonal tourism while the coastal hinterland is becoming the home of permanent residents, who continue to work in coastal cities or in the tourism industry. An unexpected trend emerged with the launch of the 'Périssol Act' in 1997. This was intended to make rented housing available to young people and middle/low classes, and give tax assistance to owners of new buildings for rent. Growth in construction on the coast was lower than average in France. However, a boom in new houses in the coastal hinterland occurred which was much higher than in the rest of the country.

Trends show an increased concentration of the population along the shoreline. This is depicted in the map of Brittany above.

Note: A strong gradation of population density from the shore to the interior.

Source: IFEN (See www.ifen.fr — accessed 13.04.2005).

Figure 6 Increase of area occupied by diffuse residential sprawl in the 10 km coastal zone (1990–2000)



Source: EEA, 2005.

as on the Mediterranean coast in France, Spain and some parts of Italy. On the Atlantic, the entire French coast, the Spanish Atlantic regions (the Basque country and Huelva) and certain stretches of the Portuguese coast are also intensively occupied. Many North Sea coasts are also very intensively built-up, such as the Netherlands and Belgium. In contrast, the areas surrounding the Baltic Sea and Ireland have fewer urban surfaces. In fact, only the southern part of Sweden and the Greater Dublin area, Ireland have significantly built-up areas.

Urban development on the coast is often seen as a way to sustain population growth and expand and diversify economies. However, the way in which growth happens also matters. The concept of 'sustainable urban design' considers the patterns in which cities grow.

Coastal compact cities are often equipped with dynamic harbours. They tend to expand because of diversified economies and services. Labour is attracted to these areas by higher salaries and capital is more easily available due to higher short-term capital returns. As a result, they often become headquarters for global concerns. There are 281 coastal cities with a population larger than 50 000 inhabitants in Europe. Only 10 % of these have a population of more than 0.5 million, while the remaining 90 % are divided equally between 50–100 thousand and 100–500 thousand inhabitants.

The leading cause of land uptake by housing is residential urban sprawl, which on average is responsible for more than 45 % of the coast's land conversion to artificial surfaces in Europe.

Transport infrastructure development however does not consume large areas, but still acts as a main driver of artificial sprawl along the coast. In the last decade, most European coastal areas (e.g. the Mediterranean Sea, the Atlantic Sea, the Celtic and North Seas) have witnessed continuous urban growth. This is often associated with the expansion of a new transport infrastructure along the coast. A

Box 2 Case study: tourism in southern European islands

With a few exceptions (e.g. the Canary Islands and Corsica), hotels are the predominant type of accommodation in southern Europe's island regions. Taking into account the limited land area, the levels of hotel concentration in island regions appear higher than those within urban regions on the mainland. In Greece, for example, the islands of the Aegean Sea, including Crete, accounted for 43.7 % of the national hotel capacity in 1999. In Madeira and the Azores (Portugal), the figure was 11.9 % in 1999. To a lesser degree, French islands accounted for 1.6 % in 2000, while Sicily and Sardinia accounted respectively for 2.6 % and 2 % of Italian hotel capacity in 1999.

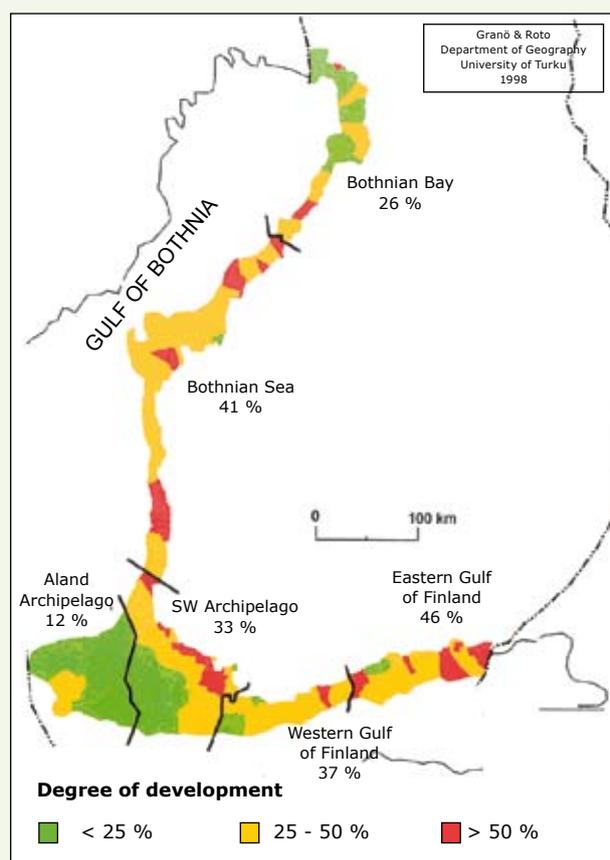
In the majority of cases, high levels of accommodation capacity are reflected in high overnight stay figures. Also, the rate in island regions fluctuates less between seasons. This is due to the fact that their sunnier climates afford them longer tourist seasons (e.g. Greece has approximately 3 000 hours of sun annually). Because of low domestic demand, island tourism is primarily based on an external clientele. Certain islands are particularly attractive to residents (e.g. Sicily, Sardinia, Northern Ireland and Corsica) while inbound tourism predominates on the Greek islands, the Canaries, the Balearic islands and Madeira. The length of stay in island regions where domestic tourism predominates conforms to national averages. However, in regions where inbound tourism predominates, the averages recorded are the highest of any region.

Source: Eurostat (See http://epp.eurostat.cec.eu.int/pls/portal/docs/page/pgp_prd_cat_prerel/pge_cat_prerel_year_2005/pge_cat_prerel_year_2005_month_01/5-11012005-en-ap.pdf — accessed 22.11.2005).

Box 3 Case study: residential development on the coast in Finland

The major extension of holiday homes, in particular on the coast of Finland, has led to a situation in which one third of the total shoreline is already inaccessible to other types of uses. In many coastal districts holiday homes pose a threat to the freedom of movement for recreational purposes. Moreover, they also alter the landscape by interfering with conservation of the environment and the landscape in general. This will generate a need to adopt new measures to steer and possibly restrict any further expansion of holiday settlements in the name of public interest (Granö *et al.*, 1999).

	Coastal region	Total length of shore (km)	Length of shore on mainland and islands > ha (km)	Length of developed shore (km)	Degree of development (%)
1	Åland Archipelago	9 891	7 175	837	12
2	SW Archipelago	14 356	11 640	3 862	33
3	Western Gulf of Finland	4 860	3 869	1 402	36
4	Eastern Gulf of Finland	4 215	3 503	1 617	46
5	Bothnian Sea	10 617	8 470	3 472	41
6	Bothnian Bay	2 123	1 864	485	26
	Total	46 062	36 522	11 675	32



recent study on urban sprawl carried out for several countries from different parts of Europe identifies the type of urban sprawl having the greatest effect. Results show that in absolute terms the sprawl in large cities with a population of more than 500 000 people and medium sized cities of between 100 000 and 500 000 people is greater than for smaller cities of between 50 000 and 100 000 people. This is

because sprawl consumes the area with the same factor (i.e. 2–3 times the core city surface) in all city categories (EEA internal report on urban sprawl, 2005).

A significant part of residential urban land uptake results from tourism development, which leads to the building of hotels, apartments and second homes.

Often these new residential quarters create uneven seasonal activity patterns as they are only used in summer and remain empty for the rest of the year.

While good European data on the number of beds in hotels within coastal zones are not available, national values for coastal countries show significant increases between 1990–2000. Strong growth in the last decade took place in Germany, Spain and Italy and this continued until 2003. France also has large numbers of beds, but growth has been slow, especially since 2000.

Tourism is probably the largest individual sector to drive the coastal economy. In 2001, tourism represented 43 % of the jobs in coastal regions in France. It also produced four times more added value than the production of sea products and maritime transportation (DATAR, 2004). The country examples above show that tourism is growing. Although the Mediterranean is expanding the most, the Atlantic, the southern Baltic Sea and the Black Sea coasts are also likely to experience similar trends.

Tourism in Europe, especially in the Mediterranean, is closely linked with 'construction', e.g. hotels, second residences, apartments, leisure and commercial infrastructures, which facilitates the expansion of artificial areas. Therefore, tourism growth needs to be decoupled from the sprawl of man-made land cover.

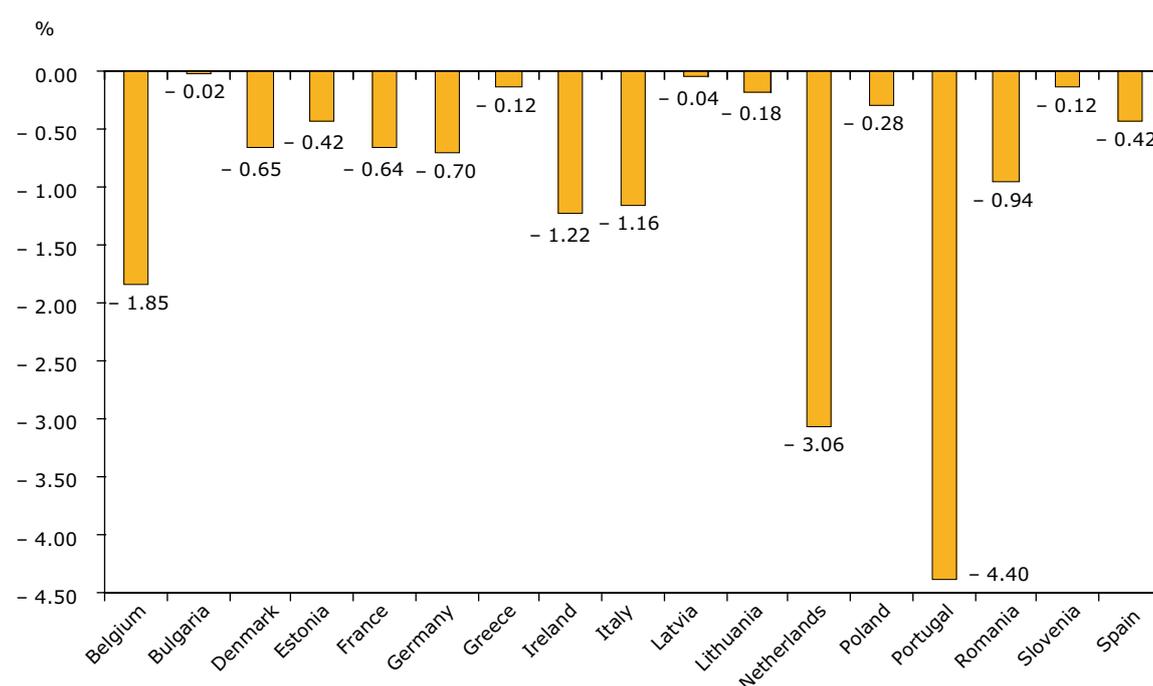
Exacerbated by tourism, the environmental impact of man-made surfaces is felt on land, water and energy consumption, waste production, habitat fragmentation. Furthermore, increased mobility creates additional pressures in most coastal areas.

At the same time, tourism resources are at risk from climate change factors, such as increasing summer temperatures, drought and even a rise in sea level. Urban settlements also are vulnerable to floods and sea storms. This may affect the choice of destination for future visitors, especially in the Mediterranean. It is also likely to have an impact on the way built up areas on the coast will develop in the future.

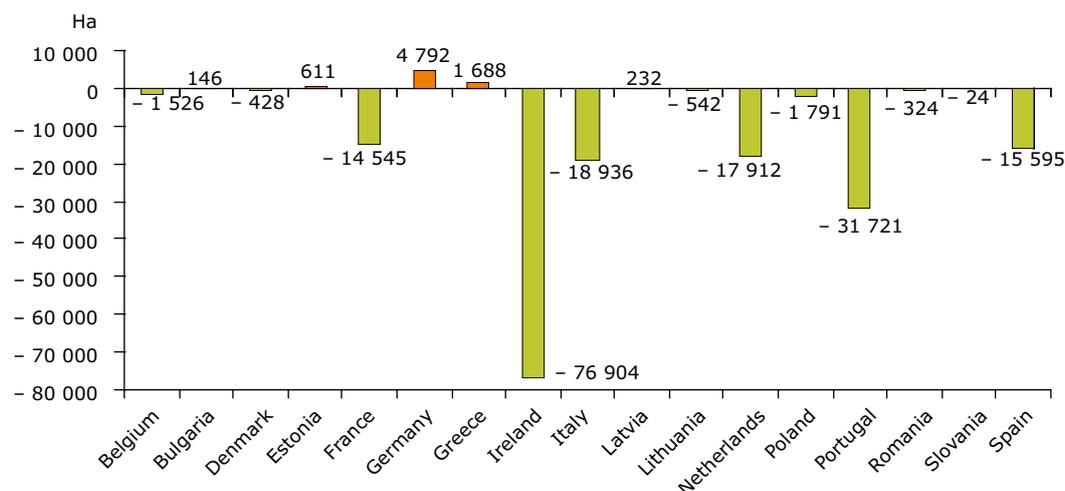
With growing income and increasing leisure time, the tourism industry in Europe is expected to grow. But this growth should be coupled with new forms of sustainable tourism and a rethinking of urban development on the coasts.

There are also contrasting trends which are pertinent to urban development on the coast. For example, the Cabo de Gata (Almeria region) in Spain is not as developed as the rest of Spain because it is protected by a natural park designation. Also, development in Corsica is controlled by the prioritisation of local interests. Long stretches of the Italian coast which have historical heritage are protected and new developments are prohibited. Similarly, development has been limited in some stretches

Figure 7 Change of total agricultural land in the 10 km coastal zone (1990–2000)



Source: EEA, 2005.

Figure 8 Net changes in pastures and mixed farmland in the 10 km coastal zone (1990–2000)

Source: EEA, 2005.

of coastal Greece. Island factors, such as size and location, and terrain may explain this.

2.4 Agricultural and forest areas

Urbanisation on the coasts has been growing strongly. However, built-up areas are still not the dominant land use form along Europe's coasts. Most of the territory is characterised by other land uses where agriculture and nature still coexist. Therefore, it is necessary to monitor changes in these areas as well.

Almost 2 000 km² of agricultural lands were lost along all coastal zones at varying rates for different European countries between 1990 and 2000. Expressed as a percentage of total country area, this process is most pronounced in Portugal, the Netherlands, Belgium, Ireland and Italy. In most cases arable lands are lost to urban development, especially if driven by higher land prices in areas adjacent to settlements, e.g. the Netherlands, Germany, Estonia and Italy. However, in Ireland, Portugal, Lithuania and Spain gains of arable land have been made.

The loss of pastures and mixed farmland totals 1 230 km², which is almost double that of arable land losses. The largest conversions have occurred in Ireland (769 km²), Portugal (317 km²) as well as Italy, the Netherlands, France and Spain. However, some pasture and mixed agricultural areas are converted into arable land, which compensates for arable land losses. Agricultural statistics reveal that this change is related to an increase in forage production for cattle, especially for milk production. A less significant amount of pasture area has been taken over by forests. This has occurred as a result of the

abandonment of farmland in regions suffering from marginalisation or depopulation (e.g. in Estonia, Latvia, Romania and south of Italy).

Forest and transitional woodland areas on Europe's coasts increased their total area by almost 500 km² between 1990 and 2000. This net change, resulting from gains and losses of forestland in different coastal zones, represents only a slight increase of 0.57 %. Forest coverage of coasts ranges from 60 % in Latvia to 1.35 % in Romania. Furthermore, trends in forest areas also vary markedly between coasts. Coastal forestlands have remained stable in most countries. However, in Ireland coastal forests have grown by 30 % and in the Netherlands by 10 %. More significantly, positive forest trends can also be found in Greece, Denmark, Slovenia and Germany. In terms of conversion fluxes of other lands to forests, pastures and mixed farmland withdrawal is the most common cause of forestation.

In contrast to forests, natural grasslands, heathland and the sclerophyllous vegetation of coasts decreased by almost 400 km² between 1990 and 2000.

In some coastal areas, especially in the coastal hinterland of the Mediterranean, urban development has grown very rapidly on abandoned farmland. These are usually areas where young forests have grown in the last decades and trees are often not managed properly because of abandonment. Newly created woodlands often become construction areas for new residential housing or second homes. As a result, these areas become extremely vulnerable to forest fire. In traditional rural society an agricultural buffer existed between houses and the forest. In many places, this has now disappeared.

2.5 Natural areas

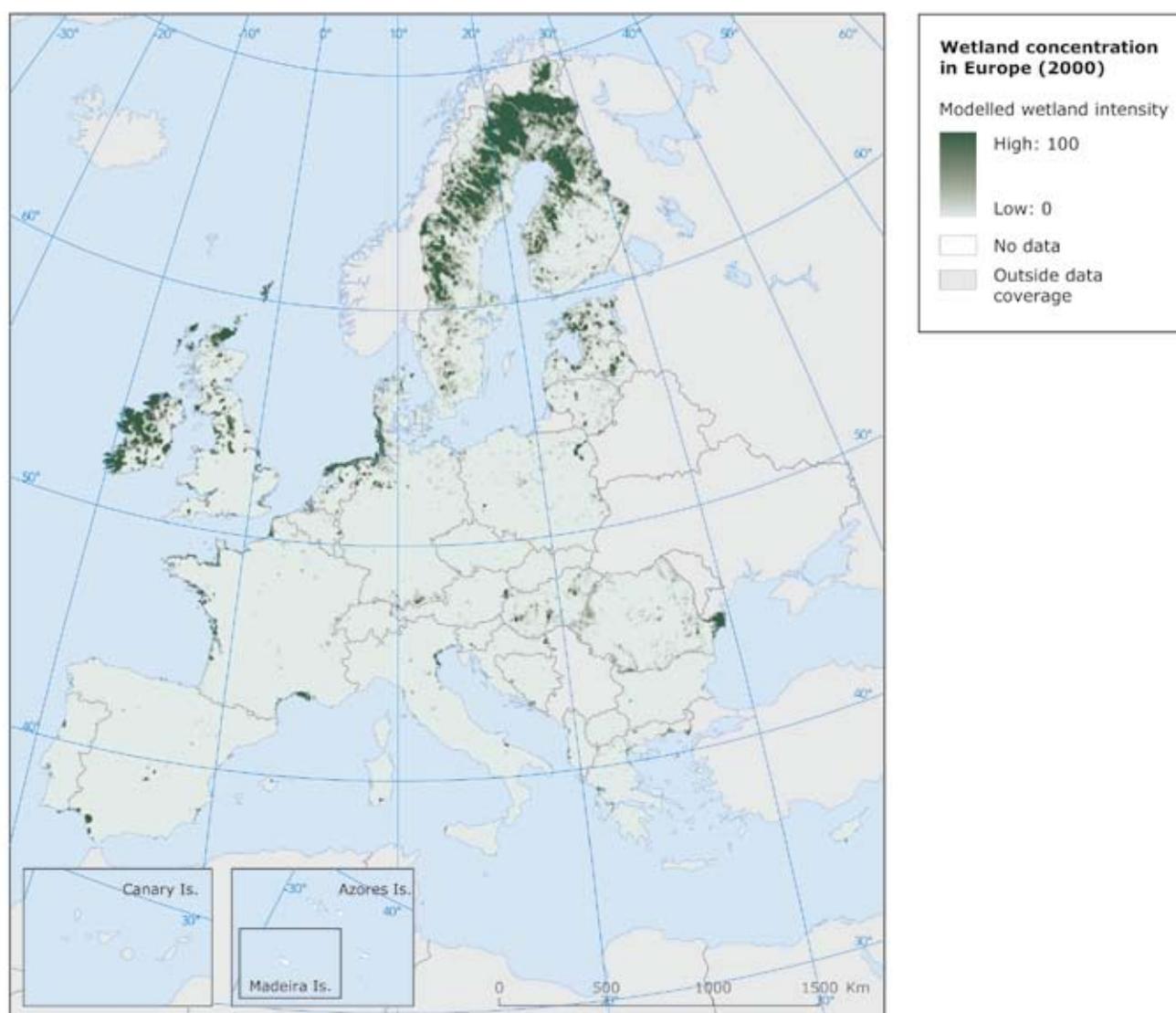
Wetlands, including freshwater and coastal, are among the systems where multiple problems of resource over-exploitation, pollution, degradation and even conversion are occurring simultaneously, and seriously affecting the well-being of people (MEA, 2005a).

Although most wetlands are extensively used, they still have low economic value. This lies in stark contrast to their high ecological value. With the aid of modern technology it is possible to convert most wetlands into dry land quickly and cheaply. This, coupled with the enormous development pressure on European coastal zones and low levels of public awareness about the function of wetlands, has contributed to massive losses.

As the focus of this report is on the spatial trends within coastal wetlands, it should be noted that the accuracy of wetland change assessment is influenced by the 25 ha mapping limit of the Corine land cover (CLC) database. Many wetlands and their related changes are smaller in size, and the total coverage of coastal wetlands is likely to be underestimated.

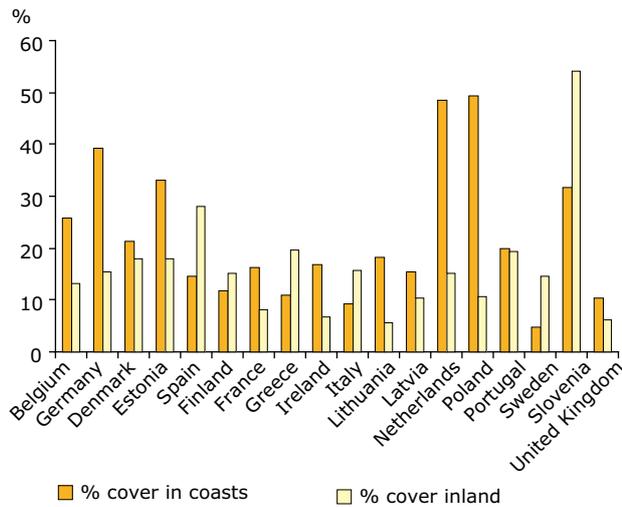
In 2000, wetland coverage of coastal zones varied between countries. In some countries more than 10 % of the coast was covered by wetlands, e.g. Romania (26 %), Ireland (21 %), Germany (14 %) and Netherlands (11 %). But in eight coastal countries wetland areas represented less than 2.5 %. Between 1990 and 2000, the total wetland changes on the coast (including losses and gains) resulted in a net loss of 390 km². A significant proportion of this can be attributed to peatland afforestation in Ireland

Map 6 Wetland concentration in Europe (2000)



Source: EEA, 2005.

Figure 9 Natura2000 areas in coastal zones and inland (2005)



Source: EEA, 2005, based on Natura2000 database.

(EEA, 2005), while changes in other countries remained marginal.

Healthy and naturally functioning coastal ecosystems have value in their own right and offer the greatest potential for the maximisation of long-term, social and economic objectives. Natura2000 is the EU's principal policy instrument for ensuring the conservation of valuable European habitats. It comprises a network of Sites of

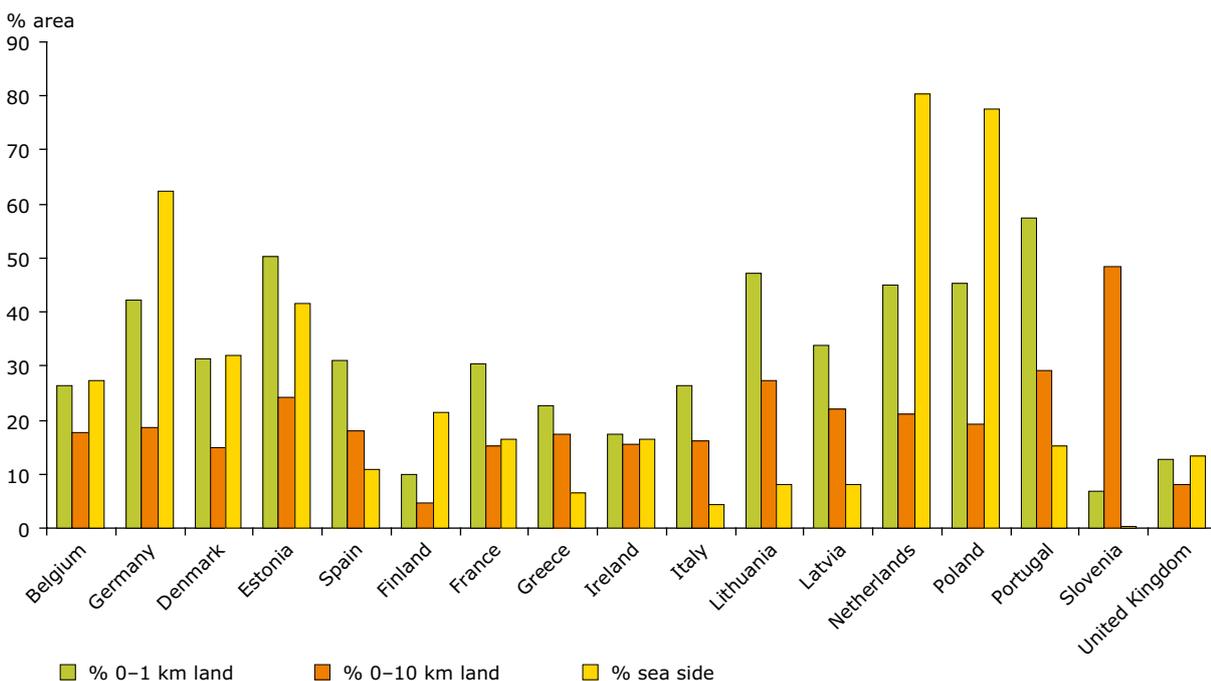
Community Interest (SCIs) and Special Protection Areas (SPAs), designated under the habitat directive and the birds directive.

For the EU-15, more than 70 % of coastal regions (NUTS3) have at least one Natura2000 site. Moreover, there is relatively more Natura2000 designated areas within the coastal zones (i.e. in both land and sea area) than inland. However, there are marked regional differences. For example, a higher proportion of area is designated on the coast than inland in Poland (x 4), Netherlands (x 3), Lithuania (x 3), Germany (x 2.5) and in Belgium, Ireland and France (x 2). A less pronounced trend is observed in Spain, Greece, Slovenia and Italy, where the relative Natura2000 coverage inland is higher than along the coasts.

Within coastal zones the first kilometre strip receives higher protection than the coastal hinterland. However, in some countries designation of the marine section of a coastal zone (defined here as 10 km seaward from the coastline) is most extensive.

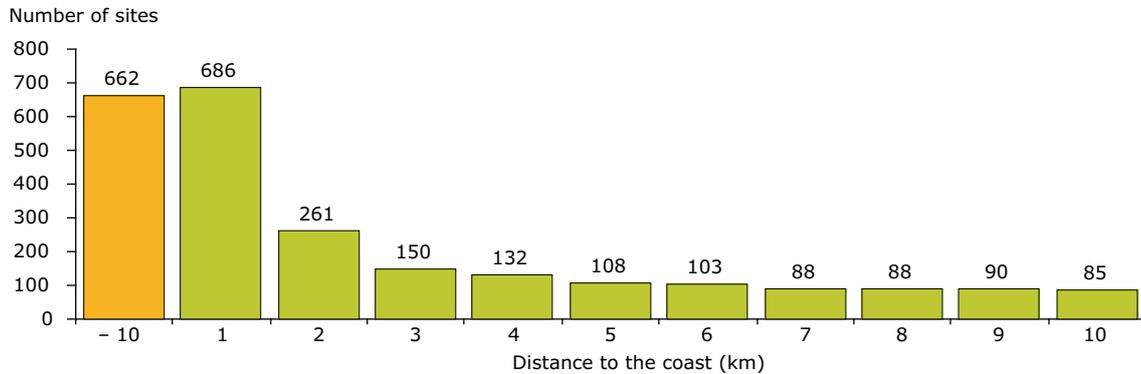
Habitats of European interest (Annex I of habitat directive) cover about 46 % of the total area designated as coastal Natura2000 sites. These habitats include mostly coastal and halophytic habitats (approximately 3 000 km²), dunes (250 km²), natural grasslands (600 km²) and forests

Figure 10 National coastal zones covered by Natura2000 sites (2005)



Source: EEA, 2005, based on Natura2000 database.

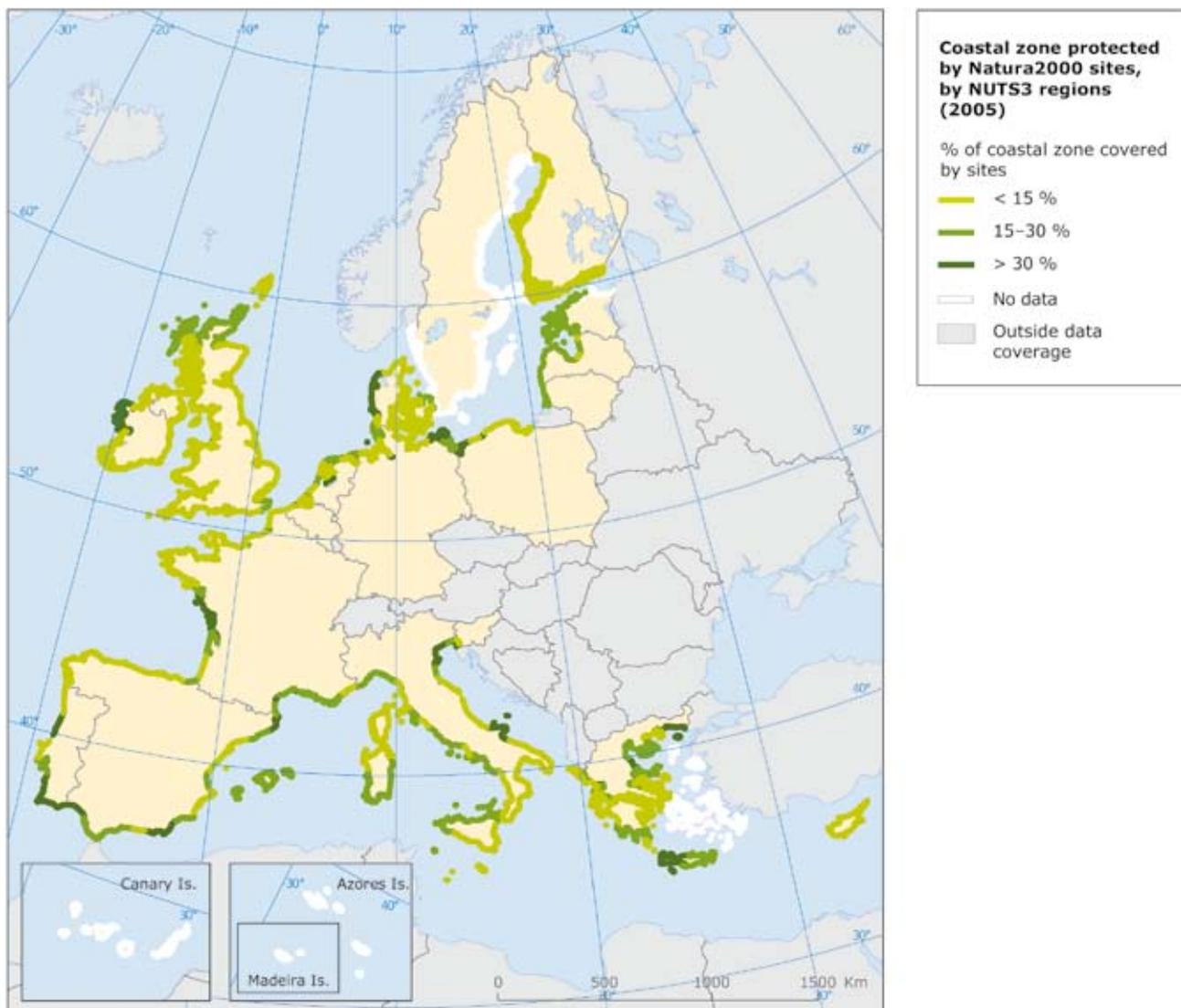
Figure 11 Distribution of Natura2000 sites in 1 km bands from the coastline and 10 km band seawards



Note: The analysis of Natura2000 sites has been based on centre points of the actual site areas.

Source: EEA, 2005, based on Natura2000 database.

Map 7 Coastal zone protected by Natura2000 sites (2005)



Source: EEA, 2005, based on Natura2000.

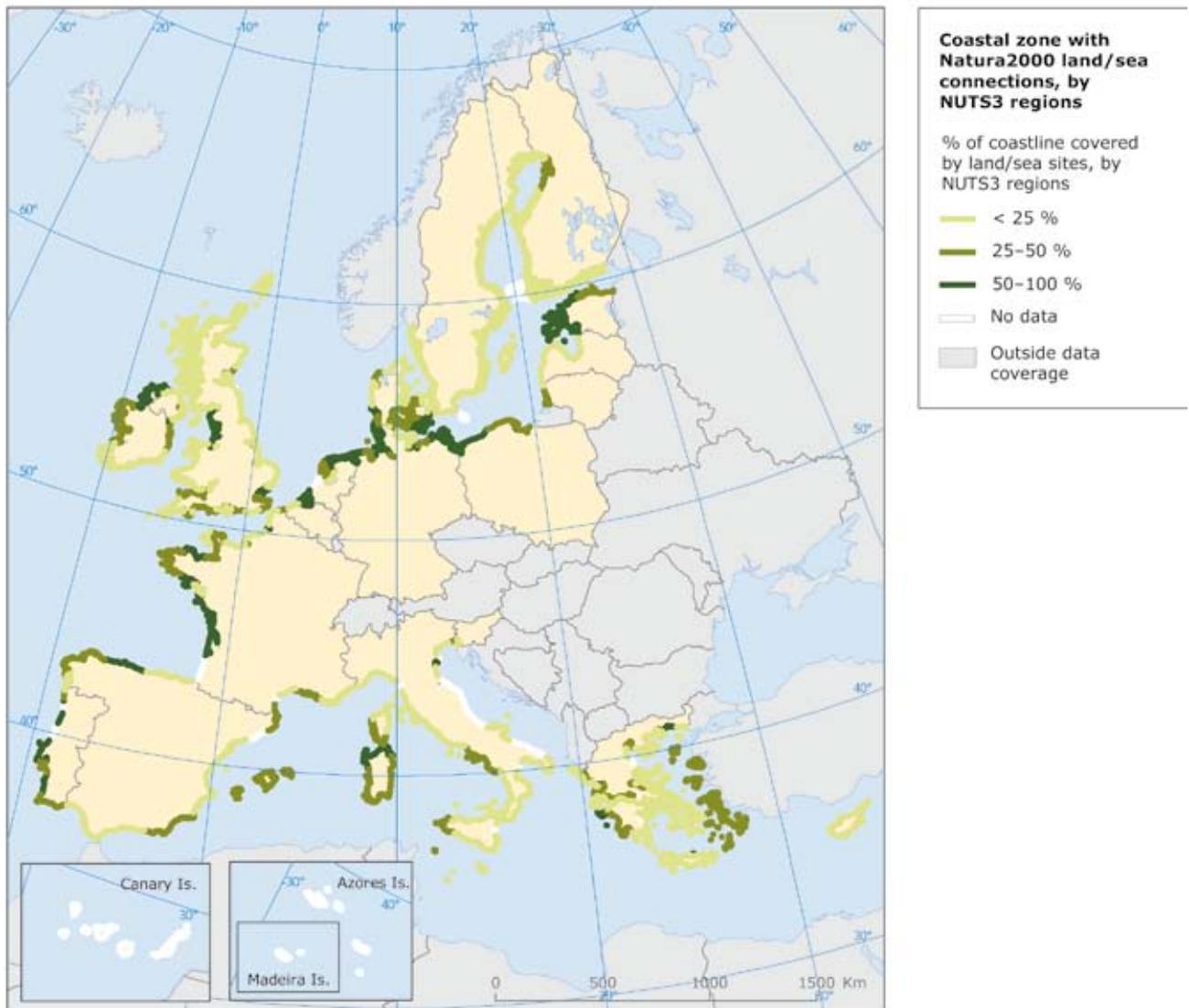
(400 km²). Among coastal and halophytic habitats, 'sandbanks slightly covered by sea water all the time' amount to approximately 800 km², 'large shallow inlets and bays' 460 km², 'coastal lagoons' 330 km², 'mudflats and sand flats not covered by seawater at low tide' 310 km², estuaries 250 km², reefs 120 km², 'boreal Baltic islets and small islands' 110 km², 'Posidonia beds' 80 km², and 'Atlantic Sea meadows' 80 km². The remaining habitats cover a total of 80 km².

Under Natura2000 a number of sites have been designated to include the land-sea connection. The share of these sites (i.e. the % of coastal length that these sea-land sites represent in each NUTS3) is especially important in the Baltic countries, along the Polish and German coast, in Denmark,

along some stretches of the Netherlands, along the Atlantic coast of Ireland, France, along some stretches of the United Kingdom and Portugal, north Sardinia and in some parts of Greece. These sites often include important estuaries, low lying coasts or rocky areas.

However, a follow-up of the biodiversity status from Natura2000 is not possible at present. Indicators for assessing the effectiveness of the designated areas in the long-term conservation of species and habitats are still under development. As most of the Natura2000 sites have only recently been officially designated, it is too early to produce an overview of their management. Therefore, the adequacy of protection measures of the main coastal habitats remains unclear.

Map 8 Coastal zone with Natura2000 land/sea connections, by NUTS3 regions



Source: EEA, 2005, based on Natura2000.

2.6 Coastal waters

Eutrophication has been recognised over many years as one of the most important problems facing European coastal waters. Furthermore, it exhibits significant regional and seasonal variability. In order to assess eutrophication, it is important to monitor the evolution of nutrient releases. In addition to known terrestrial inputs of nitrogen, such as riverine transport, the atmospheric deposition of nitrogen compounds has been significant. 30 % and 25 % of the total nitrogen discharges occur from the atmosphere in the North Sea and the Baltic Sea, respectively.

In general, nitrogen and phosphorus loads in coastal waters have been decreasing, and wastewater treatment has improved significantly since the 1980s in all parts of Europe. In several countries in north-western Europe a significant increase in the number of households receiving tertiary wastewater treatment occurred during the 1990s, resulting in marked reductions in phosphorus and nitrogen discharges. The situation is less favourable in the Mediterranean, but coastal waters are less vulnerable to nutrient surpluses, with the exceptions of hot spots in the North Adriatic or the Lion Gulf.

Nutrient concentrations in Europe's seas have generally remained stable over recent years. Higher nitrate concentrations are especially prevalent

in coastal and transitional waters. In general, nutrient loads are decreasing in all parts of Europe. However, nutrient concentrations do not show a similar trend. Chlorophyll-a concentrations, which are generally highest in estuaries and close to river mouths, reflect the land-based inputs of nutrients.

The impact of eutrophication on submerged coastal ecosystems can be well assessed by monitoring the persistence of turbid conditions (i.e. reduced water transparency) in coastal and transitional waters. By relating water quality to ecosystem health, this indicator shows the impact of continuous water turbidity on the benthic communities of the coastal sea floor. Examples of such an impact include the decline of sea-grass meadows which is due to the deterioration of water quality in European coastal waters.

Coastal managers need to know the extent to which coastal waters are safe and whether a monitoring system is to be deployed. The water framework directive sets standards for the areas within which monitoring is required, but a certain level of uncertainty remains concerning the extent of 'transitional waters'. This is especially the case for the areas of estuarine discharge. Whilst the monitoring data have to be collected *in situ*, one of the indicators for the definition of the relevant area to monitor is the persistence of turbid waters. Specific algorithms are needed to identify these

Box 4 Riverine inputs of nitrogen and phosphorus in the Baltic Sea lowest in 2003

In 2003, the total riverine (including coastal) nitrogen load entering the Baltic Sea amounted to 460 000 tonnes, and the total phosphorus load to 20 000 tonnes. Both these figures were the lowest recorded during the period 1994–2003. Excessive nitrogen and phosphorus loads coming from land-based sources are the main cause of the eutrophication of the Baltic Sea. About 75 % of the nitrogen load and at least 95 % of the phosphorus load enter the Baltic Sea via rivers or as direct waterborne discharges. About 25 % of the nitrogen load occurs as atmospheric deposition.

Riverine nutrient loads consist of discharges and losses from different sources within a river's catchment area. These sources include: discharges from industry, municipal wastewater treatment plants, scattered dwellings, losses from agriculture and managed forests, natural background losses and atmospheric deposition. According to the Helcom Fourth Baltic Sea Pollution Load Compilation (PLC-4) report, diffuse loads (mainly from agriculture) contributed almost 60 % of waterborne nitrogen inputs and 50 % of phosphorus inputs. As a result of the improved treatment of industrial and municipal wastewater, nutrient discharges from point sources were reduced significantly between 1985 and 2000.

Nitrogen and phosphorus loads vary considerably from year to year, depending mainly on hydrological conditions. In periods of high run-off, nutrients are abundantly leached from soil, increasing the loads originating from diffuse sources and natural leaching. The annual freshwater inflow (riverine run-off) during the period 2000–2003 was quite low compared to previous years, and 2003 in particular was exceptionally dry. This means that even though figures for both nitrogen and phosphorus loads for 2003 were the lowest during the whole period 1994–2003, it cannot be concluded that this trend is a result of the effective implementation of measures to reduce nutrient loads in the catchment area.

Source: Helcom (See www.helcom.fi — accessed 16.05.2006).

Box 5 Sea grasses communities can illustrate status of coastal marine ecosystems

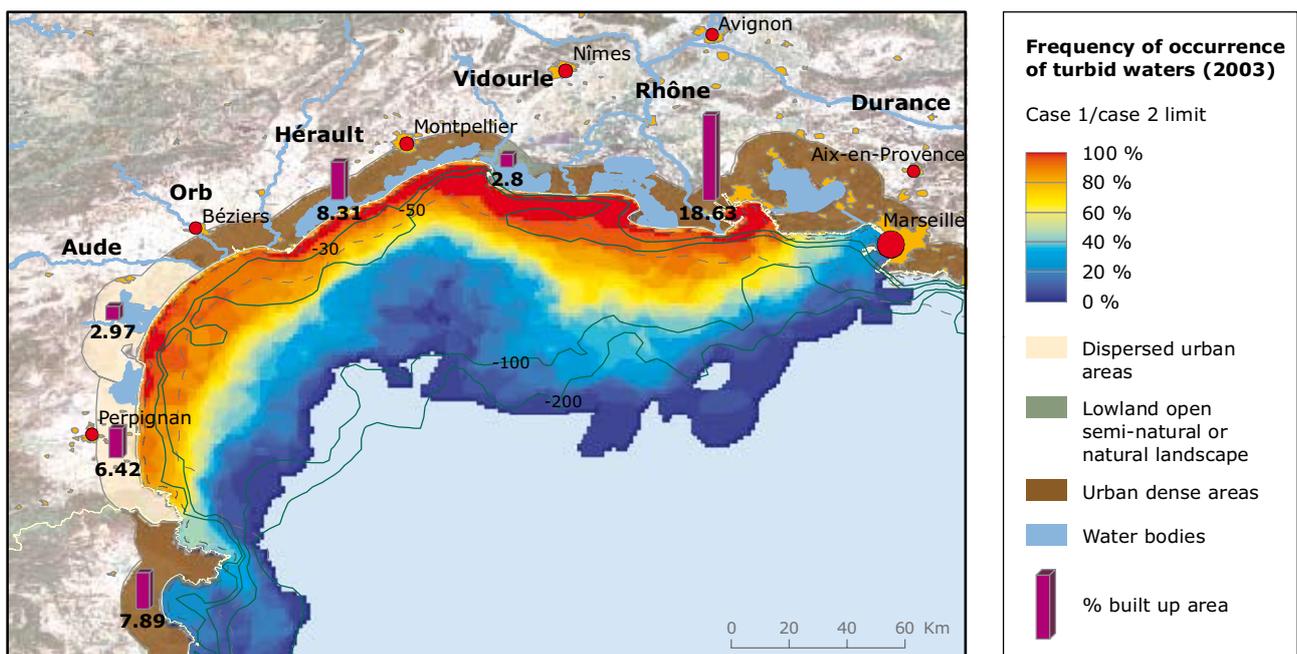
Sea grass meadows produce a variety of ecological goods (e.g. finfish and shellfish) and services (e.g. the maintenance of marine biodiversity, regulation of the quality of coastal waters and the protection of the coast line) which are directly used or beneficial to man. Sea grasses are very vulnerable to water quality. Widespread eutrophication is leading to the global deterioration in the quality of coastal waters. This is identified as a major factor for the loss in sea grass meadows worldwide. Light is one of the most important factors in the regulation of sea grass maximum depth distribution and therefore sea grasses only grow in shallow coastal waters at depths receiving sufficient sunlight. In contrast to the terrestrial environment, light is a limited resource in the aquatic environment. As light attenuates exponentially with increasing depth, light attenuation can also happen in turbid water. Therefore, in a situation of persistent turbidity, the sea grass community either migrates upwards in search of light or dies. The overall distribution and abundance of sea grasses have declined during the last century, and the main cause is reduced water quality.

Source: Borum *et al.*, 2004.

turbid water zones from earth observation data. The growth of turbid waters, which are variable in time and space, indicate the degree of sensitivity of these zones to human activity (via sediment transport and mobilisation), and the potential impact of detrimental or noxious discharges. Map 9 illustrates the concentration of turbid waters in the near-shore zone. Turbidity results from the growth of river plumes (Rhône, Hérault, Orb) and re-suspension, due to wave action, of sediments from the seabed in shallow waters.

Heavy metals and persistent organic substances still pollute many sections of European coastal waters, although pollution loads for a number of known substances are decreasing. However, it is important to note that the current level of information available for the Mediterranean and the Black Sea is insufficient. There is also evidence to suggest that this decrease is leading to a fall in the concentration of these substances in marine biota in Europe's seas. However, concentrations above limits deemed safe for human consumption are still found in mussels and fish from the estuaries of major

Map 9 Frequency of occurrence of turbid waters (from 0 to 100 %) along the coast between Marseille and the Spanish border (2003)



Source: ACRI and EEA, 2004.

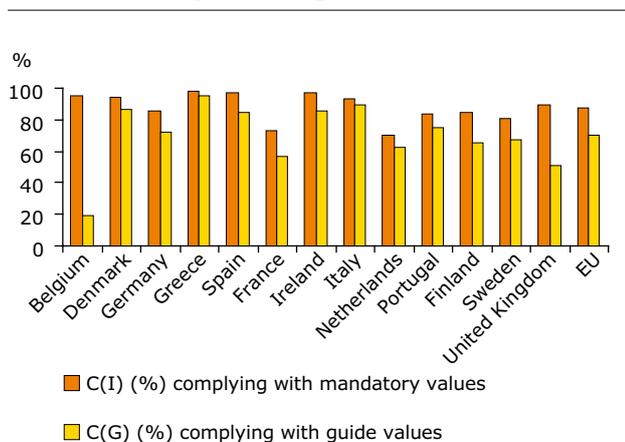
rivers located near industrial point discharges and in harbours.

Oil discharges from refineries and offshore installations have been decreasing since the 1980s despite an increase in the corresponding industrial activity. During the nineties, the total refinery output across EU increased by 15 % while discharges decreased by 70 %. Data series from 1974–2004 suggest that discharges from offshore extraction activities and refineries added up over 50 % of the total incidence of oil spills (ITOPF ⁽⁵⁾).

The number of illegal oil spills from ships has slowly decreased in the North Sea since 1997. However, they remain constant in the Baltic Sea. No aerial surveillance is conducted over the Mediterranean and the Black Seas, but there are indications that these seas are heavily polluted by illegal oil discharges. Oil spills are becoming the biggest accidental threat to the coasts (EEA, 2004), and correlate with the location of the main European oil shipping routes.

Bathing water quality is an example of a spatially distributed and policy relevant indicator for assessment of trends in one (microbiological) aspect of coastal water quality. In 2004, the percentage of bathing areas complying with the mandatory values remained virtually unchanged and relatively high at over 98 %. The percentage complying with the more stringent guide values was slightly down on the previous bathing season but remained high at 88.5 %; a percentage still above the level observed in 2002.

Figure 12 Average (1992–2003) of bathing water sampling points compliance in percentage of the total number



Source: EEA 2005, based on European Commission, bathing water directive (See www.europa.eu.int/water/water-bathing/index_en.html — accessed 08.03.2005).

⁽⁵⁾ www.itopf.com/news.html — accessed 10.02.2005.

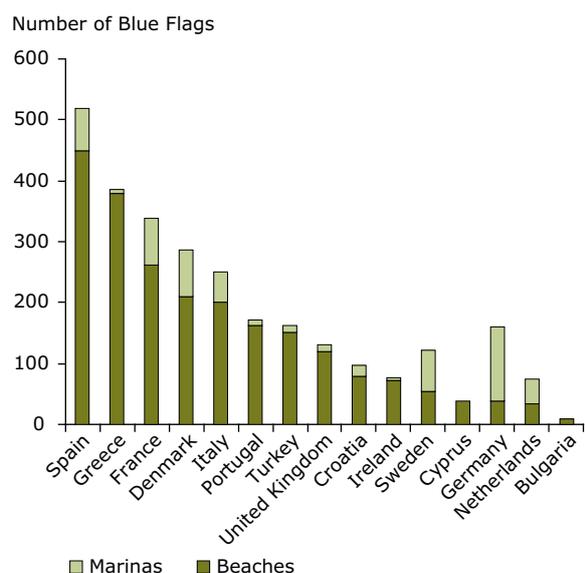
New proposals agreed by the EU in 2005 to revise the bathing water directive (1976) will help to achieve even better bathing water quality and halve the risk of contracting health problems. Over 98 % of the 179 new bathing areas monitored during the 2004 bathing season complied with the mandatory values and the vast majority also complied with more stringent guide values as well.

The quality of beaches and waters is of primary importance for tourism destinations. Coastal economies enjoy the benefits of the good bathing water quality and expanding annual denominations for Blue Flag (Note: Blue Flag is an eco-label from the Foundation for Environmental Education). It works towards the sustainable development of beaches/marinas.

There is an increasing demand for water for drinking, tourism activities and irrigated agriculture (including the intensive greenhouse cultivation) and for local industries, especially in southern Europe. When natural water resources start to run scarce, the desalination of sea water becomes an option. However, waste from the desalination process may affect coastal water quality and threaten littoral ecosystems, if it is not managed carefully.

Biological invasion by non-native species constitutes one of the leading threats to natural ecosystems

Figure 13 Blue Flags in marinas and beaches (2004)



Source: EEA, 2005. Based on Blue Flag (See www.blueflag.org — accessed 09.03.2005).

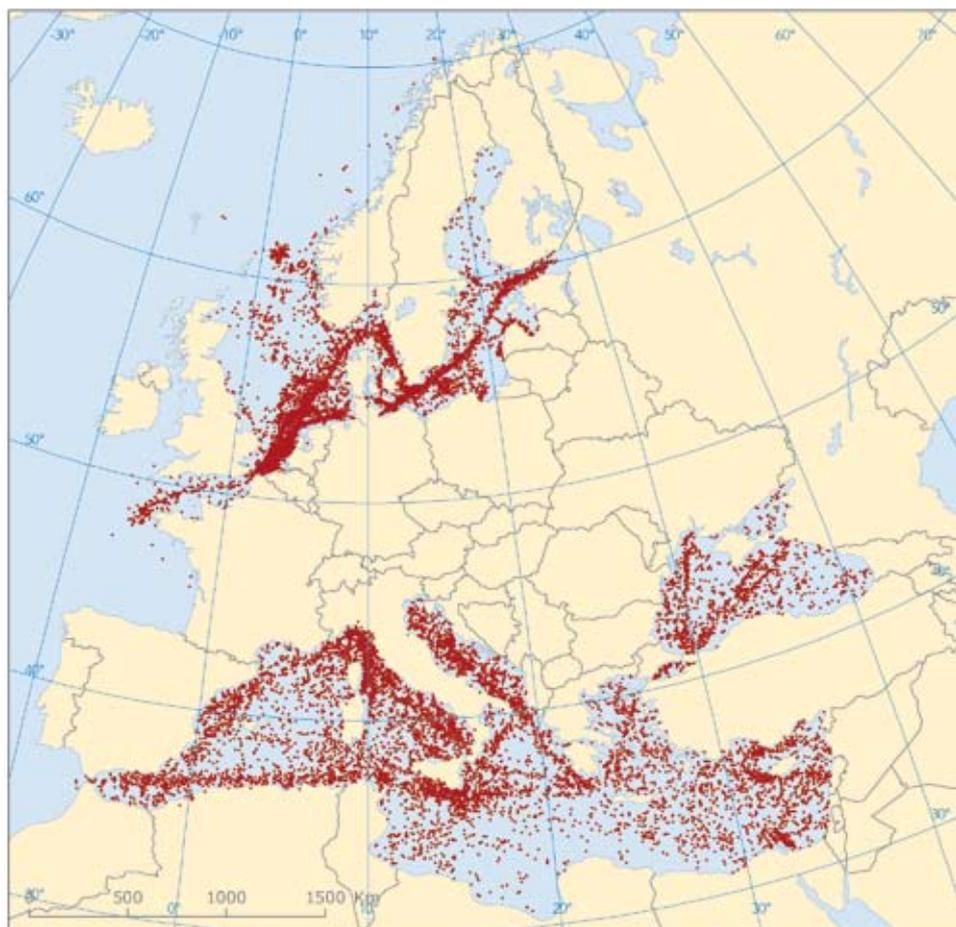
and biodiversity. Invasive species are growing in number, and their effect on native coastal ecosystems is becoming difficult and costly to control. A considerable number of alien species has been introduced in European waters. Their number dramatically increased between the 1960s and 1980s, particularly in the Mediterranean. While remaining high, the total number of introductions of alien species has remained stable or even decreased in the last two decades. *Caulerpa taxifolia* is an example of non-native species invasion, which threatens the Mediterranean Posidonia meadows. Another frequently reported example is the jellyfish *Mnemiopsis leydyi*. An explosive growth in its population occurred after its arrival in ships' ballast waters in the late 1980's. This caused devastation in Black Sea fish stocks, oyster and even the indigenous jellyfish population (EEA, 2005b). The jellyfish even found its way into the land locked Caspian sea, causing serious changes to the whole ecosystem (Karpinsky *et al.*, 2005).

The global sea surface temperature has warmed by a mean of 0.6 °C since the late 19th century. This change is likely to be even more pronounced in some regional seas that are either fully-enclosed or semi-enclosed such as the Black Sea, the North Sea, the Baltic Sea and the Mediterranean. The result of sea surface warming is a redistribution and loss of marine organisms.

The rise in the sea surface temperature and the intensified eutrophication phenomena may cause a higher frequency of anomalous and toxic phytoplankton bloom events and the enhancement of hypoxia on the seabed.

Phytoplankton algae blooms have been on the increase over the last several decades (JRC, 2005). Algae blooms may produce high biomass quantities at sea and sometimes become toxic for fish, wildlife and humans. The potential danger of algae blooms depends on their toxicity and

Map 10 Oil spills in European regional seas (2000–2004)



Oil spills detected in the European regional seas (2000–2004)

- Oil spills

Note: In the North and Baltic Seas the oil spills were detected by aerial surveillance, but in the Mediterranean and Black Seas by radar images (e.g. probable spills). Varying amount of surveillance in different seas may represent disproportionate amount of pollution.

Source: JRC, 2005.

Box 6 Waste management in water desalination in Andalusia, Spain

The Province of Almería is one of the driest areas in continental Europe with an annual rainfall of around 200 mm. It is also an area with the highest concentration of intensive agriculture production. Surface water is a particularly scarce resource in Almería and intensive over-exploitation of underground waters along the coast has led to the salinisation of the principal aquifers.

An important initiative from the Spanish Ministry of the Environment and the Autonomous Government of Andalusia has been the development of desalination infrastructures along the driest areas of the Almería's coast. One example is the Carbonera's Desalination Plant. With a budget of EUR 254 million (co-financed by EU Regional funds, ACUSUR-Spanish Ministry of the Environment and local farmers) it is able to produce 120 000 m³ of drinking water per day. The water is used by 200 000 inhabitants living in the coastal municipalities of Almería for drinking, tourism activities, greenhouse intensive agriculture and supporting the maintenance of local industries.

Brine (waste from the desalination process) is mixed with waste water from the neighbouring energy power plant's cooling system. The salt concentration is significantly reduced and therefore the resulting impact on coastal waters is considerably low. The Andalusian Ministry of the Environment periodically controls the salty spills in order to maintain the status of the coastal biodiversity and protect the Cabo de Gata Natural Park's waters.

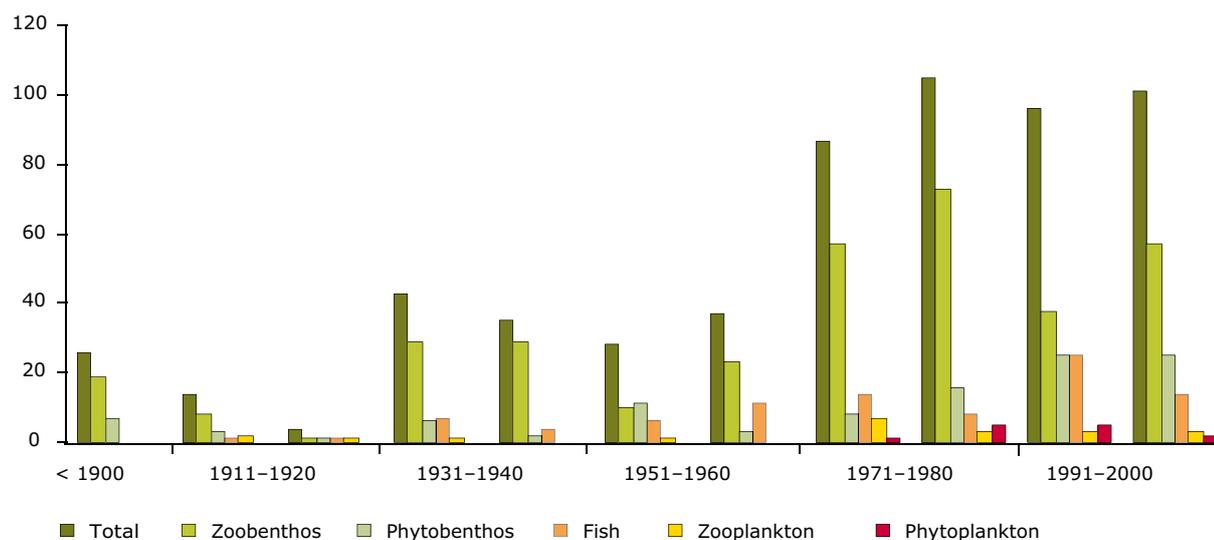
Source: Spanish Ministry of the Environment (See www.mma.es — accessed 9.07.2005) and Andalusian Ministry of the Environment (See www.juntadeandalucia.es/medioambiente/site/aplica/medioambiente/site/web/menuitem.48ed6f0384107256b935619561525ea0/?vgnnextoid=72c01efbae625010VgnVCM1000000624e50aRCRD — accessed 21.01.2005).

geographic distribution. In addition, Harmful Algal Blooms (HAB) may contribute to oxygen depletion but also disturb recreational activities. Therefore events are carefully monitored at regional sea

level by, for example, the Baltic Sea Portal⁽⁶⁾ and the European Initiative on Harmful Algal Blooms (EUROHAB⁽⁷⁾).

Figure 14 Rate of detection of exotic species in the Mediterranean Sea

Number of new species



Source: UNEP/MAP, 2004. Marine pollution indicators fact sheets.

⁽⁶⁾ www.fimr.fi/en/itamerkanta/levatiedotus.html — accessed 01.03.2006.

⁽⁷⁾ www.cordis.lu/eesd/ka3/cluster5.htm — accessed 01.03.2006.

The decomposing residues of algae and plants (compounded by direct organic pollution) deplete water oxygen, creating anaerobic 'dead zones' devoid of life forms. Such dead zones have been discovered in many lakes and estuaries and off the mouths of several large rivers. They are growing, even though this increase is only of a seasonal nature. Hypoxic zones may also occur naturally at the bottom of semi-enclosed seas, such as the Black Sea and the Baltic Sea, where permanent anoxic conditions prevail. In the Baltic Sea, the dynamics of the anoxic seabed in deep water is changing due to influxes of more oxygen rich ocean water from the Atlantic. In both seas these oxygen depleted areas seem to have been widening in recent years (EEA, 2005b). In contrast, no significant trends in hypoxia are observed in the North Sea and the Mediterranean. However, recurrent near-shore local events can be seen along the Aegean Sea and in the North Adriatic (JRC, 2005).

2.7 Coastal dynamics and risk

Coastal erosion has a major impact on European coasts, and affects the environment and human activity. It is largely caused by human activity in the form of river dams, intensive development and the use of sand for construction and engineering purposes. Rising sea levels and increasingly frequent storms and floods are likely to exacerbate this problem. Human activity reduces or blocks sediment

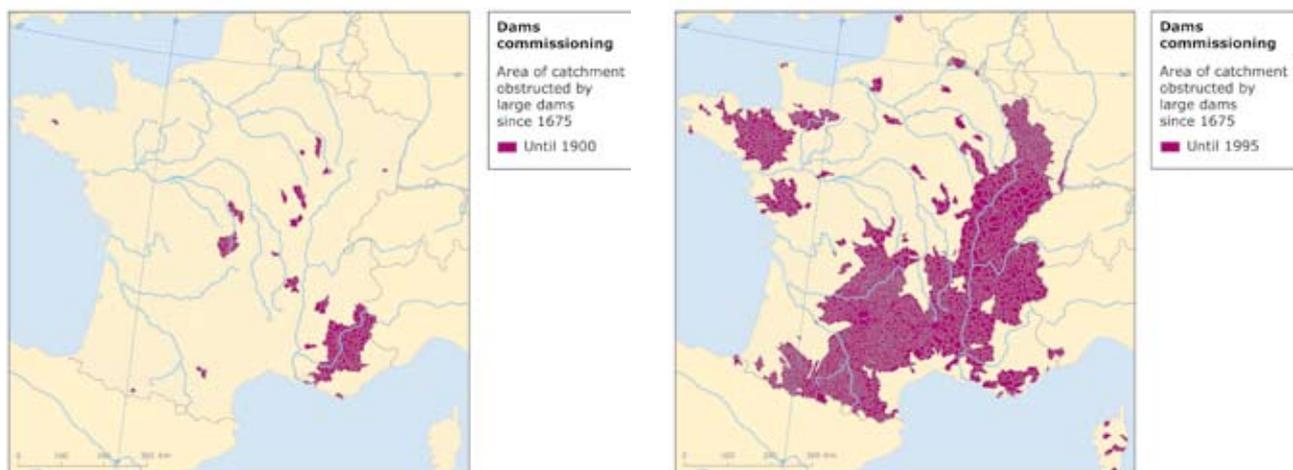
supply to the coast itself, which may give rise to the retreat of the coastline through wave erosion.

River sediment flux plays an important role in the sediment budget of the coast. Less river sediment discharge alters the sedimentation-erosion equilibrium within the coastal zone. Since coarse-grained bed sediment load represents only a small fraction of the total sediment discharge delivered to the coast, it has been assumed (MEA, 2005b) that a decrease of approximately 5 % of the total sediment flux represents the critical threshold beyond which the coastal system is likely to deteriorate.

It should be noted, however, that erosion is a natural process which allows accretion in other parts of the coastline. It is not negative per se, but becomes a risk for settlements and human population.

Rivers are unable to carry their sediments to the coast. Moreover, there is an overall deficit of sediments resulting from dam construction on discharging rivers and from channelisation of rivers. This deficit of sediment is estimated to be 100 million tonnes annually for Europe (Eurosion⁽⁸⁾). Therefore, the sustainability of sediment balance is an important challenge for Europe's coastal zones. Strengthening coastal resilience by restoring the sediment balance will require identification of areas where essential sediment processes occur, and establishing 'strategic sediment reservoirs' from

Map 11 Catchments with regulated rivers in France (1900 and 1995)



Note: Large dams as defined by International Commission on Large Dams (ICOLD).

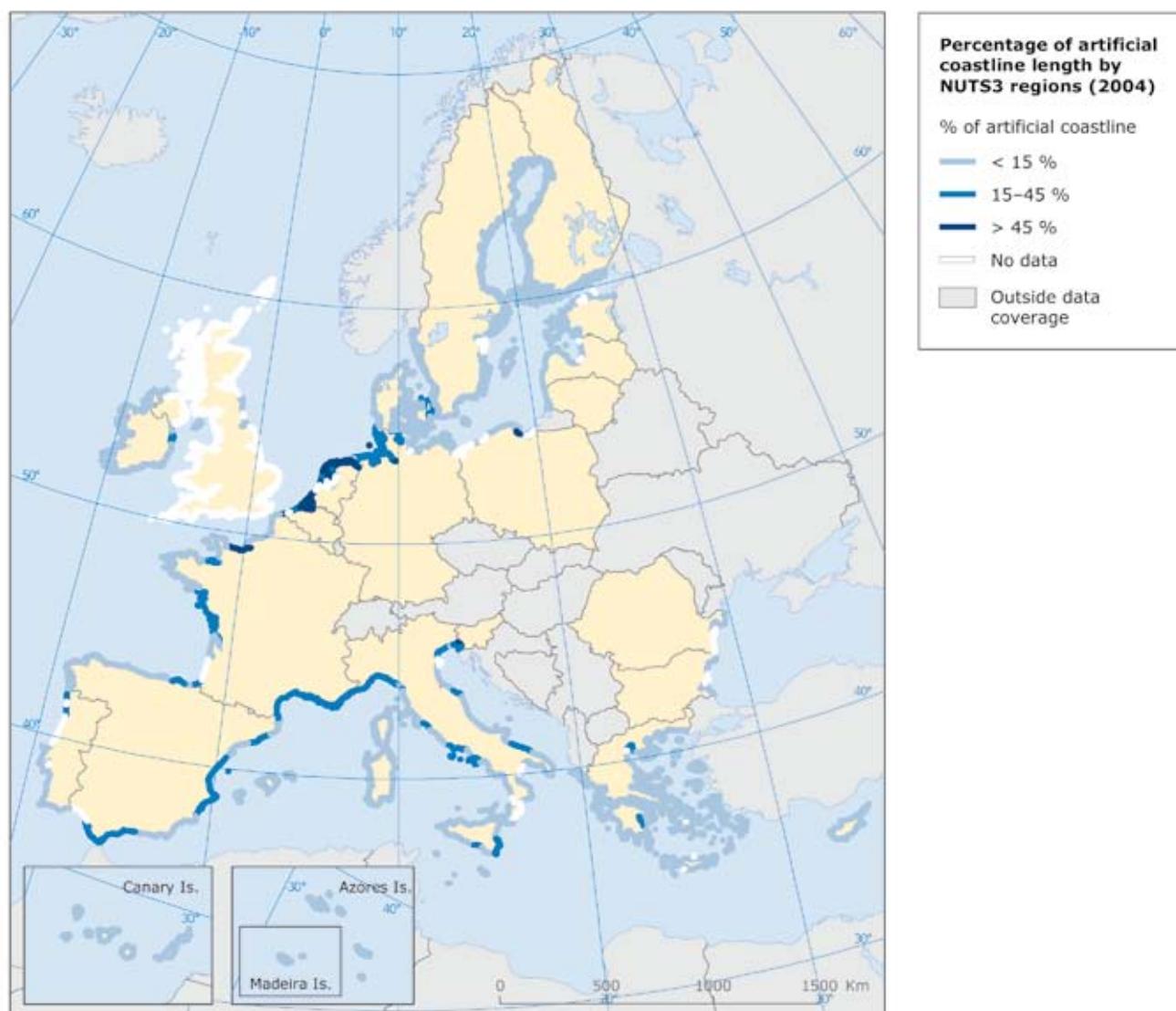
Source: EEA, 2005, based on Eurosion, 2004.

⁽⁸⁾ www.eurosion.org — accessed 17.03.2005.

Box 7 Large dams create coastal sediment deficit

The longest river in Lithuania is the Nemunas (937 km). From springhead to outlet, the Nemunas descends 176 m and debouches into the Curonian lagoon, forming a large poly-branched delta. Before the construction of the Kaunas hydro-electric power station in 1959 the Nemunas carried around 0.9 million tons of outwash to the delta and the Curonian lagoon per year. Today sediment discharge is 1.8 times less than in 1959 and measures 0.5 million tons.

Source: Lithuanian Central Internet Gates (See www.lietuva.lt/index.php?Lang=5&ItemId=29589 — accessed 15.04.2005) in accordance with publications of K. Kilkus, J. Taminskas, and others.

Map 12 Percentage of artificial coastline length by NUTS3 regions (2004)

Source: EEA, 2005, based on EuroSION, 2004.

which sediment can be taken without affecting the natural balance.

According to the EuroSION database, 10 % of the EU's coastlines are already artificial and have coastal

defence systems or harbours. In 21 European NUTS3 regions more than 50 % of the coastline is artificial and densely populated countries with relatively short coastlines (e.g. the Netherlands, Belgium and Slovenia) have the most shoreline conversion to

man-made surfaces. A fifth of the EU-25's coastline is already severely affected, with coastlines retreating by 0.5–2 metres per year, and in a few cases, by as much as 15 metres. Current data show that about 25 % of European coastlines experiences erosion.

It is widely debated that possible sea level rise and an increase in the strength and frequency of storms may cause more coastal erosion and coastal floods or inundations. Many countries have assessed the potential threats from climate change to their coastal areas. On a European scale, the EuroSION project offers information on the relative sea level rise at 237 locations along the European coastline,

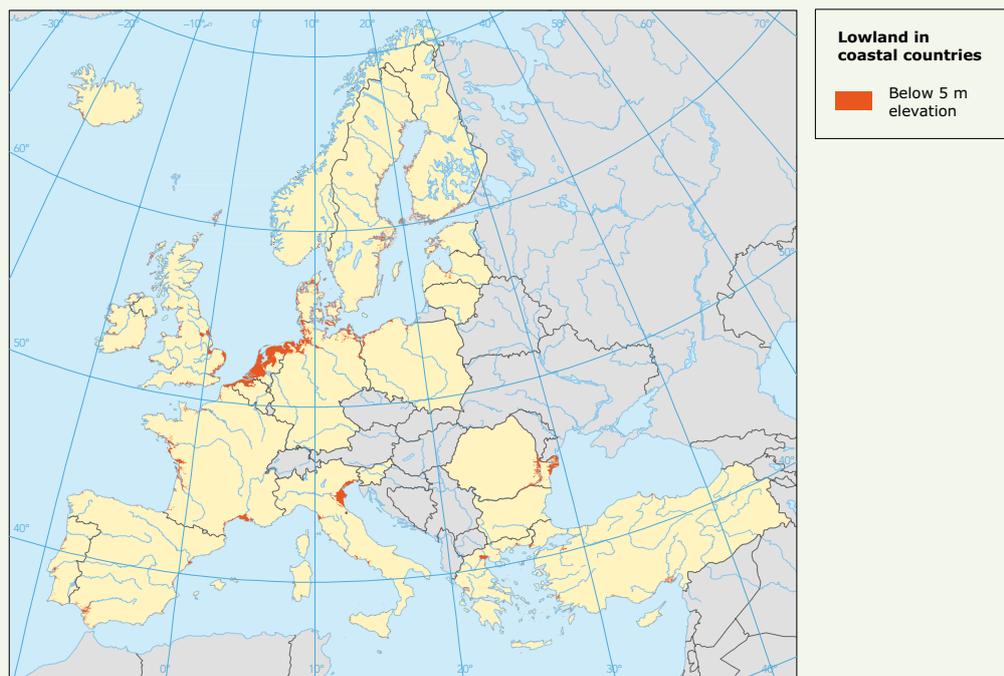
Box 8 European coastal lowlands most vulnerable to sea level rise

Almost 100 000 km² of Europe lies below a 5 m elevation. This figure constitutes 2 % of the total territory of 20 coastal EU (and candidate) countries. More than half of this area is located closer than 10 km from the sea (10 km zone), which means that 9 % of all European coastal zones (12 % for EU Members States) lie below a 5 m elevation. These areas are potentially vulnerable to sea level rise and related inundations.

The most vulnerable countries are the Netherlands and Belgium, where more than 85 % of coast is under a 5 m elevation. Other countries at risk include Germany and Romania where 50 % of the coastline is below 5 m, Poland (30 %) and Denmark (22 %). In France, the United Kingdom and Estonia low coasts cover 10–15 % of the country. Eight countries, mostly in southern Europe, have less than 5 % of their coastal zones below 5 m. However, individual hot spots exist. The most significant of these is the area surrounding Venice in Italy.

When combining this information with the likelihood of severe storm surges, the vulnerability of these coastlines becomes even more apparent. Surge heights with 50-year extreme maxims of up to 3 m above normal level are observed in north-western Europe, e.g. in southern North Sea shores, and, to a lesser extent, the southern and eastern Baltic coasts.

Today, the majority of coastal lowlands have ageing defence systems. Considerable resources are needed to maintain and improve these systems, and their eventual capacity to withstand a sea offensive is not unlimited.



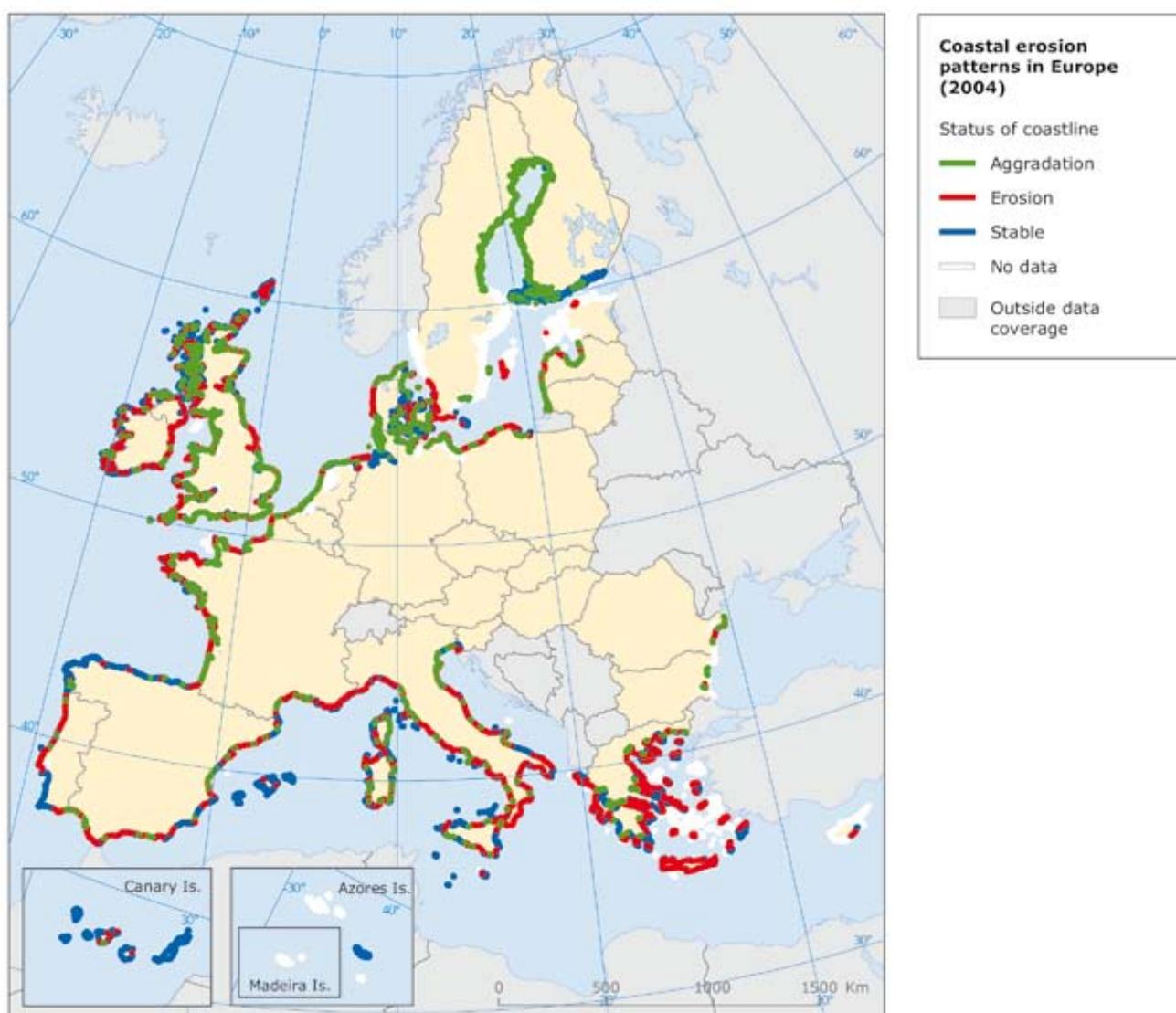
Note: The DEM/DTM is compiled by EEA and derived from the GTOPO30 dataset from U.S. Geological Survey.
Source: EEA, 2005.

Box 9 Case study: sea level change affecting the spatial development in the Baltic Sea region (Interreg IIIB project SEAREG)

The SEAREG project was partly co-financed by the Interreg IIIB programme of the European Union and studied examples of sea level change scenarios. The leading partner was the Geological Survey of Finland. The project aimed to strengthen the linkages between planning and decision-making, and climate change adaptation. The results of global climate models from the Intergovernmental Panel on Climate Change (IPCC) were downscaled for the Baltic Sea region and applied to local case study areas. The northern part of the Baltic Sea region faces lower sea level rise, as the post-glacial rebound lessens its impact. The sea around northern Scandinavia will rise up to 9 mm/yr, whereas western Pomerania will experience a subsidence of about 1 mm/yr. Land loss caused by inundation could be negligible in sparsely populated areas. Meanwhile in areas with high population density and housing built close to the shore similar land loss may be more serious.

Source: SEAREG (See www.gtk.fi/projects/seareg — accessed 19.10.2005).

Map 13 Coastal erosion patterns in Europe (2004)



Source: EEA, 2005, based on EuroSION, 2004.

Map 14 Salt water intrusions into groundwater in Europe (1999)

Source: EEA, 1999.

and provides a total value for economic assets located within 500 metres of the European coastline. This value includes beaches, agricultural land and industrial facilities. The figure is currently estimated at EUR 500 to 1 000 billion.

Human exposure to sea flooding on the European coast is unevenly distributed, and the impact of sea level rise is expected to be more local than global. Low coastal areas and small islands are at more risk than others, but contemporary land level movements may also be a factor. Land subsidence as a result of groundwater withdrawal or compaction may become increasingly relevant for some cities, while other areas may experience isostatic land up-lift. This may result in the relative sea level rise becoming smaller.

Besides sea level rise, changes in the frequency and/or intensity of storms and associated surges are expected. Even more significant than the direct loss of land caused by the sea level rising are the associated indirect factors. These include erosion patterns and damage to coastal infrastructure, the salination of wells, suboptimal functioning of the sewage system of coastal cities (with resulting health impacts), loss of littoral ecosystems and loss of biotic resources.

Higher temperatures, especially if combined with irrigation, growing population and tourism pressure can create increased demand on water resources. In 10 out of 12 countries where over-exploitation

of groundwater are reported, saltwater intrusion results. Large areas of the Mediterranean coastline in Italy, Spain and Turkey are reported to be affected by saltwater intrusion (EEA, 2003). Across Europe more than 100 areas in 10 countries are affected by marine saltwater intrusion and only in 16 areas (three countries) is saltwater intrusion caused by the rise of highly mineralised water from deeper aquifers.

Lagoon ecosystems are fragile due to water from developed areas, their shallowness and low water volume to surface ratio. As a consequence, there is a high probability that coastal lagoons will be the first to react to consequences of changes in climatic trends. Sea level rise will increase water depth in the lagoon, alter water circulation and salinity, affect solid transport and erosion-sedimentation equilibrium and erode the lagoon barriers (JRC, 2005).

2.8 Maritime economy and coastal uses

Maritime activities have a clear positive impact on economic and social conditions at the coasts. For example, the maritime economy in France totalled EUR 18.5 billion in 2001 (DATAR, 2004). At EU level, shipbuilding, ports, fisheries and related services industry employ 2.5 million people. At the same time, maritime activities such as tourism, maritime traffic, fisheries, aquaculture and offshore energy installations may often have adverse environmental impacts.

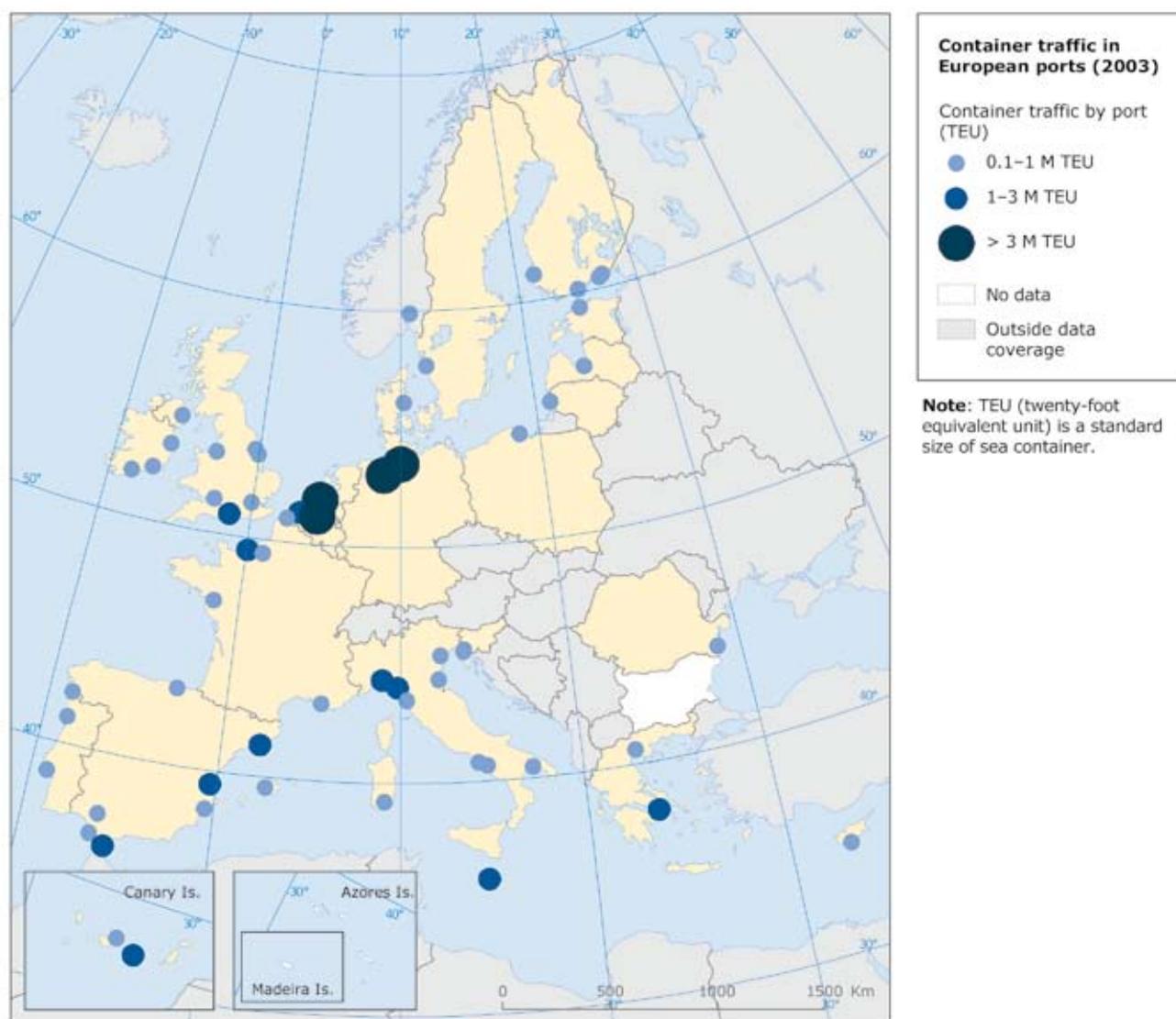
The intensity of maritime transport has been continuously growing. The pressure of shipping on European coastal waters can be assessed by the short-sea shipping indicator. This deals with the transport of goods between European destinations, and includes the entire coast of the Mediterranean Sea and the Black Sea (Eurostat, 2006). In terms of volume, short sea shipping is extremely important in the European Union. Between 1991 and 2001 it grew by around a third to approximately 1 270 billion tonne-km. This is comparable with road transport demand. During 2003 Italy and the United Kingdom received the most vessel arrivals in terms of tonnage. Container traffic is largely bound to specialised ports on the southern North Sea coast. Overall, European sea transport showed an ascending curve with an

annual growth of approximately 1 % for the period 1997–2001. Passenger traffic is heavily dominated by ferry links, which extend transport networks to the seas with all the related consequences to the environment.

Over the past decade the marine fisheries sector has experienced a crisis. This crisis is structural rather than temporary and no immediate end is foreseeable. Marine fisheries are generally overcapitalised, and many stocks in the European coastal seas, the eastern Atlantic, the Mediterranean Sea and the Black Sea are over fished and/or seriously depleted.

According to the EEA ⁽⁹⁾, the total fish landings of all species in all European sea regions (North-East

Map 15 Container traffic in European ports (2003)



Source: ISEMAR (See www.isemar.asso.fr — accessed 10.02.2005).

⁽⁹⁾ [http://themes.eea.eu.int/Sectors_and_activities/fishery/indicators/FISH11 %2C2004.05/index_html](http://themes.eea.eu.int/Sectors_and_activities/fishery/indicators/FISH11%202004.05/index_html) — accessed 25.01.2006.

Box 10 Maritime traffic in the Baltic Sea

The issue of maritime safety is given the highest priority in the Baltic Sea region. The Baltic is a relatively small sea with many rocky shallows, narrow straits and labyrinthine archipelagos. It also experiences harsh wintery conditions. The Baltic Sea is criss-crossed by some of the busiest shipping lanes in the world. The intensity of shipping activities here has been growing very rapidly over the past decade, and there is no sign of this trend slowing down. There are approximately 2 000 ships at sea at any one time, accounting for 15 % of the world's cargo transportation. All types of cargo are shipped in and out of the Baltic Sea countries, including oil and hazardous substances. Every day 150–200 large tankers are filled with oil in 20 ports around the Baltic.

The size and number of ships have been on the increase. Today some tankers in the Baltic carry as much as 100 000 tonnes of oil, which increases the risk of a major oil spill. Every year about 70 shipping accidents occur in the Baltic Sea. Fortunately, most of them do not cause notable pollution. However, a single large-scale accident could seriously threaten the entire Baltic marine environment.

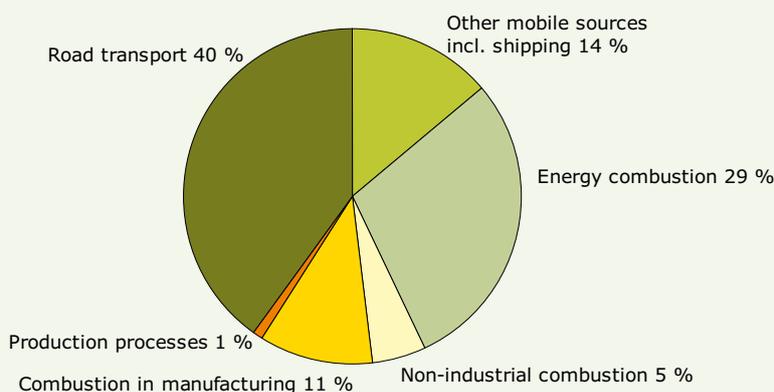
Forecasts predict a further 40 % increase in oil transportation by 2015 from today's level of more than 160 million tonnes a year. Cost factors would already favour the use of even larger tankers able to carry 100 000–150 000 tonnes of oil.

Source: Helcom Newsletter 3/2005 (See http://Helcom.navigo.fi/stc/files/Publications/Newsletters/Newsletter_03_2005.pdf — accessed 09.06.2005).

Box 11 Air emissions of NO_x from ships

The shipping sector is one of the main sources of NO_x emissions in the Baltic Sea. Shipping contributes to approximately 16 000 tonnes of nitrogen deposition indirectly into the Baltic Sea and to approximately 8 000 tonnes into the North Sea. Shipping emissions of NO_x are expected to continue increasing, as nitrogen emissions are not extensively regulated in the shipping sector.

Percentage of total emissions of nitrogen oxides (NO_x) from different sectors in the Helcom Contracting Parties



Source: Helcom (See www.helcom.fi — accessed 16.05.2006).

Atlantic Ocean, including the North and the Baltic Seas, the Mediterranean Sea, the Black Sea and the Arctic Ocean) increased by 20 % or 1.6 million tonnes between 1990 and 2000. This was largely due to an increase in landings by vessels of the EU-15 + EFTA, which account for an average of 93 % of total European (European Economic Area) landings by

weight. Landings by EU-15 + EFTA vessels increased by 19 % or 1.59 million tonnes, while landings by AC-13 (now EU-10 and EU candidate countries) and Balkan vessels increased by 30 % or 190 000 tonnes. Landings peaked in 1997 at 12 million tonnes and declined to 11 million tonnes in 2000. Increases or decreases in landings do not, however,

signal a healthy or unhealthy fishing industry or environment. Increases in fish landings may be driven by either increasing amounts of available fish or a greater fishing effort. Similarly, decreasing landings may be the result of a lack of available fish or a change in management measures or fishing patterns. The seas around Europe contribute the majority of landings by European countries i.e. European countries are not heavily dependent on landings from sea areas outside European sea regions. Since 1990, dependence on landings from distant waters has declined from 21 % or 2.5 million tonnes to 8 % or 0.9 million tonnes.

In seeking to satisfy the growing demand of 370 million consumers in EU Member States, European fisheries have been obliged to exploit unconventional species and products, equip trawlers to harvest deep water resources and seek extra supplies through fishery agreements elsewhere in the world.

This latter option poses a challenge to the coherence of the EU's policies. EU support for rational resource management by developing countries may clash with pressures for access to the same country's fishing grounds by fleets whose capacities are in excess of requirements for domestic EU waters (EEA, 2005b).

Since 1990 aquaculture production has increased by more than 35 % in the EU-15 and EFTA countries. This growth has mostly taken place in fish rather than shellfish production. As a result, increased pressures on water, ecological quality and ecosystems have occurred. Norway is the largest producer. In 2003, it produced 600 000 tonnes per year; 90 % of which was Atlantic salmon. Other major producers include Spain, France, Italy and the United Kingdom. Turkey is the largest producer among new Member States and candidate countries. The majority of production takes place in marine and brackish environments. The share of freshwater production is modest and further decreased from 7.4 % in 1990 to 7.0 % in 2001. Aquaculture production intensity as measured per unit of coastline length has reached an average of around 8 tonnes per km of coastline in EU-15 and EFTA countries compared to two tonnes per km in new Member States and candidate countries.

As aquaculture becomes a major user of the coastal zone waters, its pressures on the coastal ecosystems are starting to be felt. In particular, the marine finfish culture (mainly Atlantic salmon) is now making a significant contribution to nutrient loads in coastal waters. Moreover, the impact on marine fish stocks becomes important, as about 3 to 6 kg of wild fish are needed to produce 1 kg of farm fish.

Table 3 Offshore wind energy capacity in selected EU countries (2004)

Country	Existing offshore wind energy installations	
	MW	Number of sites
Denmark	409.0	7
Germany	4.5	1
Ireland	25.2	1
Netherlands	18.8	2
Sweden	23.0	3
United Kingdom	124.0	3
Total	604.5	17

Source: EWEA, 2004.

Energy installations also make more and more use of coastal areas. The number of offshore wind farms visible on Europe's coasts has increased over the past decades, and has corresponded with the rapid expansion in total wind energy capacity.

In 2001, only approximately 250 MW of the total EU wind turbine capacity of 15 000 MW came from offshore wind installations. In 2004, the total capacity of offshore wind energy turbines in key producing countries added up to approximately 605 MW. Projections for 2010 put the share of offshore installations to around 13 % (10 000 MW), according to the European Wind Energy Association (EWEA, 2004). The proportion could reach as high as 39 % (70 000 MW) by 2020. These numbers demonstrate the huge potential of offshore wind energy plants and also the level of new activity in coastal waters.

Most existing offshore wind farms and a large majority of prospective sites are located in the north western part of Europe. Construction is encouraged by the attractive conditions of the area, e.g. shallow seas, good wind conditions and close proximity to the national electricity grid. The shallow waters of the continental shelf are also areas where offshore oil installations are established (e.g. the North Sea, the Adriatic Sea, the Strait of Sicily, and the north-east Black Sea). These conditions may lead to increased competition between the wind energy and oil industries. Therefore, sound spatial planning of coastal sea areas is required.

Dredging, seafloor mining and communication cabling boost coastal employment and, in the case of renewable energy, are providing environmental benefits. However, they also put escalating pressures on coastal zones.

3 Living by the sea

3.1 Sustainability challenges

The coast, as the interface between the atmosphere, land and sea, is recognised as one of the most important ecosystems on earth. Major movement of sediments and nutrients are powered by waves, tides and currents in water and air. This energy creates a habitat that has adapted to the very specific, diverse and, sometimes, extreme conditions of the coast. Globally, it is therefore very important for biodiversity, the delivery of ecosystem services and sustaining production for human well-being.

Coastal ecosystems provide a wide range of services to human beings (MEA, 2005b). On a global scale, these include regulation and support services, such as shoreline stabilisation, nutrient regulation, marine life nursery functions, carbon sequestration, buffering from natural hazards, detoxification of polluted waters and waste disposal. They also include provisioning services, such as the supply of food, fuel wood, energy resources and natural products, and cultural (amenity) services, such as tourism and recreation. These services are of high value not only to local communities living on the coasts, but also to national economies and global trade.

Increasing consumption per person, multiplied by a growing population, are the root causes of the increasing demand for ecosystem services. With one third of mankind living within a 50 km distance of the coast (EEA ⁽¹⁰⁾), the coastal ecosystem is among the most productive yet highly threatened systems in the world. In 2000, the world coastal population density in coastal areas was 99.6 people per km², while in inland areas the density was 37.9 people per km²; nearly three times less (MEA, 2005b). In Europe, the difference in population density is far less. Coastal regions (NUTS3) have about 10 % higher values due to historic and widespread settlement development. However, the European share of coastal population in total population is higher than worldwide figure. This is partly due to the geographic shape of the continent.

The main antropogenic drivers of coastal ecosystem change are related to development activities on land, particularly in areas adjacent to the coast. Physical demand for coastal space is increasing, and urban sprawl, resort and port development, and aquaculture are leading to changes in factors directly affecting ecosystems. Their impacts extend beyond the direct footprints from pollution, sedimentation and changes in coastal dynamics. Unsustainable management practices, over-harvesting, climate change and the associated sea level rise are also important threats to coastal habitats, such as extensive farmlands, wetlands and sea grass beds. The coast is increasingly becoming a fragile, vulnerable area whose environment suffers continuous degradation. In this context, approximately 85 % of Europe's coasts have been identified as a risk area (Bryant *et al.*, 1995).

The socio-economic development of coasts is also important. Despite some successes most coastal regions are among the least economically developed regions of the EU. In 1996, 19 out of the EU's 25 less favoured areas were coastal regions. This continues to be a key issue within an enlarged EU. Small islands are especially affected by social and economic problems (e.g. migration and lack of economic infrastructure) (CPMR, 2005). Improving living standards within coastal communities is therefore an obvious challenge for coastal peripheral regions.

So far, development along the coasts has been based on economic restructuring. This has mainly been achieved through tourism and the associated boom in construction, especially in the Mediterranean and the Atlantic coasts. Other regions have given priority to the economic restructuring of the fishing industry. Alternatively, the increase in the number of harbours and maritime transport has led to the armouring of the coast.

Following the statement by the Conference of Peripheral Maritime Regions (CPMR), there has been a real need 'to make an overall assessment' of the marine dimension of Europe's economy' (CPMR

⁽¹⁰⁾ http://reports.eea.eu.int/technical_report_2005_1207_144937/en/EEA_Technical_report_7_2005.pdf — accessed 01.03.2006.

final declaration of its 2003 General Assembly). CPMR also clearly recognises that there is a need for better, homogenised data at regional level for the entire European coast. In particular, socio-economic data, which is well represented in spatial terms, are still lacking. Therefore, it remains difficult to really assess what is going on in relation to sustainable development on the European coasts.

People who decide to live by the coast must take into account the prevailing conditions, such as the physical processes related to sea level rise and the effects of storms, flooding and erosion. A risk assessment of potential property damage from coastal natural hazards and property damage mitigation need to be addressed when living on the coast. Living by the coast should be considered as a responsibility, not just a privilege. It should be coupled with the awareness that the coast is a common asset. People not living by the coast but using its resources, such as tourists, should also be involved.

Therefore, the lifestyles and behaviour of people living and working by the sea has to be guided by both the coastal conditions themselves and the required responsibility towards sustainable development. In particular, there should be the opportunity for people to adapt their behaviour to extreme climatic events.

Water is becoming an important issue on the coast. Scarcity of fresh water is a real challenge, especially at a time when the conversion of the coast into built up and artificial land cover is growing and intensive agriculture is expanding. The risk of salination of underground water reserve aquifers, mainly due to overuse of water, is an issue particularly relevant in the Mediterranean. For example, it affects Almeria, Malta, Sicily, Cyprus and the Black Sea coasts. In some areas, sea level rise will put more pressure on freshwater availability because of aquifer salination. Sea level rise will also be a challenge for a number of coastal settlements and activities. Furthermore, the development of coastal tourism leads to increased water demand, especially during the peak season when it increases the water deficit.

Changes in natural resources (e.g. fish stocks) due to over-fishing will put higher pressures on a number of coastal communities. Aquaculture is not a clear alternative for all former fishing regions. The Atlantic and North Sea coasts, where highly industrialised fleets operate, have developed a significant aquaculture sector. In the Mediterranean, albeit among its more traditional fisheries, aquaculture has also grown in recent

years. Aquaculture is controversial and data are not available in sufficient amounts to measure the extent to which former fishermen are engaged in this new activity.

New ideas, such as attracting a specific type of tourism to fishing villages and familiarising visitors with the lifestyle, are emerging. If well organised, these activities could provide economic alternatives for communities.

For coastal safety, addressing both natural and technological risks needs to be a priority. The planning of coastal areas urgently needs to take into account all potential risks, e.g. floods, forest fires, loss of biodiversity, coastal erosion, maritime safety and oil spills. Also, the health effects of environmental pressures may pose risks to the coastal population and species populations. Harmful algal blooms and other pathogens affecting the health of both humans and marine organisms are on the rise. Moreover, alien invasive species have altered coastal ecosystems and threaten both marine species and human well-being.

A priority is to consider the coastal interface as a common asset for both local people and the whole population. National coastal laws might help to change social perception even if, in most cases, they have not been sufficient to stop occupation on the coast. For this reason, new concepts and instruments for management and planning based on a priority of common interest and not only on private interest need to be developed.

The stability of ecosystem services is critical to the functioning of coastal systems. They significantly contribute to human well-being, and represent a significant proportion of the total economic value of coastal zones. It is important to stress that the coast is not only a place to live or an issue of resource and risk. It plays a key role in the functioning of the planet. It provides a significant contribution to the global life support system by supporting the entire biosphere. For example, EU biotic marine resources largely depend on the quality of the coastal zones. If there are disruptions in these natural functions, the processes of degradation will progressively accelerate and will make any possible response from society difficult. These natural functions cannot be replaced by technology.

This issue not only concerns Member States, regions and coastal cities but also people, business and industry. The impact of ecosystem degradation will be felt in the short-term, i.e. the next five years and also in the long term. Furthermore, it will be exacerbated by climate change.

3.1.1 Climate change

Over the past century the average temperature has risen by more than 0.6 °C globally and by almost 1 °C in Europe. Among the most visible impacts of global warming are:

- the rise in sea level due to thermal expansion of ocean water;
- melting glaciers and polar ice;
- the changing frequency, intensity and spatial pattern of precipitation, coastal storms and other extreme weather events;
- increasing stress on terrestrial and marine ecosystems and species (EEA, 2005).

With the exception of parts of Scandinavia, the rise in sea levels is evident already around most of Europe's coasts. Typical values have been 1.1–1.3 mm per year over the past 100 years (Nicholls and Klein, 2005, based on data from the Permanent Service for Sea Level). Sea level rise should be coupled with the increased risk of extreme storms. Despite the fact that there is no evidence of a long-term trend in the characteristics of storms in 20th century (WASA Group 1998), the coasts are likely suffer from more numerous and stronger storms with higher wave height and sea floods. The latter will be aggravated by river floods that will be fed by local storms. It will be difficult for excess river waters to be discharged into the seas with already raised water levels.

From a northern European perspective, the formation of seasonal winter ice cover in the Baltic has declined over the last 10 years due to rising sea temperatures. This allows winter storms to cause significantly more erosion than in the past (Kont *et al.*, 2004). As a result, the impact on flora and fauna at the shoreline as well as sub-littoral is occurring (Eionet consultation, Sweden).

Changes in ecosystems and the climate increase the likelihood of unpredictable environmental disruptions, such as a collapse of previously reliable food sources, pest outbreaks, catastrophic floods or the disappearance of economical valuable species. As a result, the probability of sudden climate change is increasing. This may lead to a significant loss of biodiversity and socio-economic assets. Recently, evidence has come to light of a weakened oceanic thermo-haline circulation; part of which includes the North Atlantic current. This brings warm water north from the tropical Atlantic (Bryden *et al.*, 2005). Driven by salinity differences in the North Atlantic, this process may be impacted upon by increasing freshwater volumes released by melting polar ice caps or greater precipitation and river discharge

into the critical region. Particularly important seems to be the discharge of ice from the Greenland ice shield. The outpouring of ice has nearly doubled below 66° North between 1996 and 2000 (Rignot and Kanagaratnam, 2006). As more glaciers accelerate farther north, the contribution of Greenland to sea level rise will continue to increase.

For coastal areas, it is not the global mean sea level that matters, but the locally observed, relative sea level. This takes into account regional sea level variations and vertical movements of the land. A major uncertainty is how sea level rise will manifest itself at regional level, such as in the North Atlantic and related European regional seas. The lack of similarity in projections of different models in regional sea level change suggests that possible sea level rise around Europe's coasts could be +/- 50 % of the global mean changes (Nicholls and Klein, 2005). This uncertainty needs to be taken into account in impact analysis.

Land uplift and subsidence may also be significant. Parts of Scandinavia and Estonia experience land uplift due to global-isostatic adjustment. Furthermore, the relative sea level may continue to fall, albeit at a lower rate (Kont *et al.*, 2003). Other areas, such as deltas and coastal lowlands are characterised by the strong downward movement of the land, which will add to global-mean sea level rise. This subsidence is often greatly enhanced by land claim, reduced sediment discharge and groundwater abstraction. Consequently, the water table lowers, for example around the North Sea. Human induced subsidence in 20th century has led to 2 300 km² of land falling below sea level along the North Italian coastal plain (different sources in Nicholls and Klein, 2005).

According to the framework of analysis for climate change impacts around Europe's coasts (Nicholls and Klein, 2005), the vulnerability of coastal systems to sea level rise and other drivers of change is determined by sensitivity, exposure and adaptive capacity. 'Sensitivity' reflects each system's potential to be affected by changes such as sea level rise, and 'exposure' defines the nature and amount to which a system is exposed to climate change. 'Adaptive capacity' describes the system's stability in the face of change. Concerning the role of dynamic interaction that occurs between the natural and socio-economic systems in the coastal zone, authors emphasise the dynamic nature and capacity of both systems for adaptation. Hence, impact assessment that does not take adaptation, both spontaneous and planned, into account will generally overestimate impacts (i.e. by determining potential rather than

actual impact). However, beyond that, the realistic assessment of adaptation options requires detailed analysis in order to capture the potential variation in responses. At regional level, it may be worth protecting the whole coast, while abandoning individual flood compartments at local level. For example, 20 % of individual flood compartments could be abandoned at present rates of sea level rise. This stresses the importance of assessment scale for coastal management. The importance of multiple assessment scales is confirmed by a general finding of Millennium Ecosystem Assessment which says, '...the scale at which an assessment is undertaken significantly influences the problem definition and assessment results, as well as the solutions and responses selected.' (MEA, 2005a).

Proactive adaptation to climate change aims to reduce the system's vulnerability by either minimising risk or maximising adaptive capacity. The following IPCC classification of three basic adaptation strategies is often used (Nicholls and Klein, 2005):

- protect — to reduce the risk of the event by decreasing the probability of it's occurrence;
- accommodate — to increase society's ability to cope with the effects of the event;
- retreat — to reduce the risk of the event by limiting its potential.

Protecting coastal zones against sea level rise and other climatic changes would involve increasing long term investment and the robustness of infrastructural designs, such as seawalls and other coastal infrastructure. A strategy to accommodate sea level rise could include increasing the flexibility of managed systems such as agriculture, tourism and human settlements in coastal zones. A retreat strategy would serve to enhance the adaptability of coastal wetlands, by allowing them space to migrate to higher land as the sea level rises.

The effects of climate change and associated sea level raise threaten economic sectors on the coasts to a varying degree. Adapted from McLean *et al.*

(2001) the following socio-economic impacts can be identified in the table below.

Modified from Nicholls and Klein (2005), the major conclusions concerning climate change and long-term management of the European coastal zone are as follows:

1. Climate change and variability are already an issue and future climate change is expected to be greater than any other in human history.
2. The potential impacts on human systems will be significant, especially due to increased flood risk and storm damage in low-lying areas. Intertidal habitats and ecosystems are also threatened.
3. Coastal zones will face many other pressures during the 21st century. These will interact with climate change and exacerbate or ameliorate vulnerability to climate change.
4. The actual impacts of climate change are highly uncertain, but success in human adaptation to that change and appropriate proactive measures could help avoid or manage effectively many of the impacts.
5. There is a fundamental conflict between protecting socio-economic activity and sustaining the ecological functioning of coastal zones in Europe under conditions of rising sea levels. Obstructed by fixed sea defences, natural ecosystems cannot migrate onshore as a natural response to sea level rise. Sustaining coastal zones requires softer protection, managed retreat and possibly accommodation strategies in coastal management policy.
6. Global sea levels are likely to continue to rise for many centuries irrespective of future greenhouse gas emissions. Coastal management and land use planning should prepare for these changes, recognising the long-term commitment to adapt.

The key questions for Europe's coastal zones is: Are present practices reducing the vulnerability of coastal zones to climate change impacts? What is the role of proactive and reactive (or 'wait-and-see') adaptation policies?

Threat category	Impacts
Risk to life and economic assets	<ul style="list-style-type: none"> • Increased loss of property • Increased flood risk and potential loss of life • Damage to coastal protection works and other infrastructure
Supporting ecosystem services	<ul style="list-style-type: none"> • Loss of renewable and subsistence resources • Loss of tourism, recreation and transportation functions • Impacts on agriculture and aquaculture through decline in soil and water quality
Non-material	<ul style="list-style-type: none"> • Loss of non-monetary cultural resources and values

Box 12 Sea level change affecting the spatial development in the Baltic Sea region – case study: Pärnu, Estonia

Pärnu is located on the Baltic coast in west Estonia and has a long history as a health resort and tourist location. During recent years the tourism sector has grown rapidly. The number of beds for tourist accommodation increased from 1 319 in January 2002 to 3 379 in April 2004. The number of overnight stays more than doubled from 240 000 in 2002 to 500 000 in 2003. Among the 50 biggest companies are five centres for health and rehabilitation, employing about 1 100 employees (2003).

The 'high case' scenario with a sea level rise (SLR) of 104 cm by 2100 shows significant impact on the service sector, groundwater and protected nature areas. The impact on the service sector and protected areas can be ascribed to the loss of large sections of the coasts. The impact on the water supply is limited to the areas with no public water supply and no sewage system.

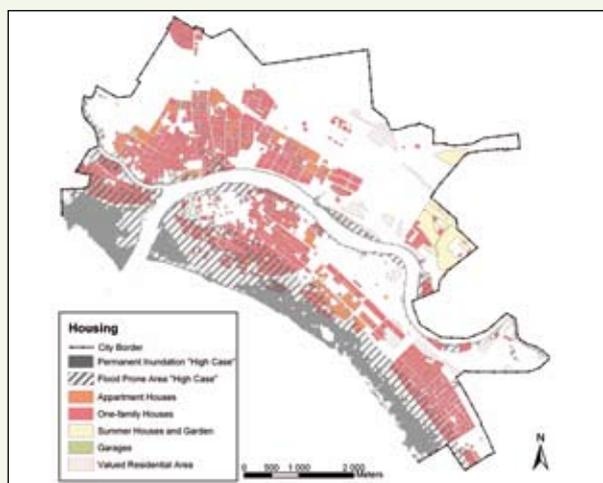
So far, there has been low awareness about SLR, and thus stakeholders have remained unprepared. Nature protection along the coast helps to keep infrastructure constructions and buildings away from the endangered areas, but there are no mitigation strategies to cope with the impact on the coastal area itself. Currently SLR could affect the water supply of Pärnu considerably because several areas are neither connected to the public water supply nor the sewage system. Short- and mid-term planning does not take SLR into consideration yet. However, there is an incentive to complete public water supply and sewage system regardless of the impact of future SLR.

In the event of a 100-year storm surge nearly all parts of daily life would be affected. Although the impact could be significant, the level of vulnerability is relatively low. In contrast to SLR, flooding is a recurrent event people are aware of. Flooding events are taken into account when constructing new buildings and protecting existing ones. If a 100-year flood is combined with the 'high case' scenario of 104 cm, SLR the projected water levels could reach 3 m above the present (1961–1990) mean sea surface. This will directly affect 25 % of the current city area. The winter storms on 8 and 9 January 2005 were one of the most severe in the last 100 years. The highest water level recorded during this storm was about 2.8 m, and large areas of Pärnu were flooded.

Water levels in 2100 relative to mean sea surface height 1961 to 1990

Scenario	Low case			Ensemble average			High case		
	Δh (cm)	Area (km ²)	Area (%)	Δh (cm)	Area (km ²)	Area (%)	Δh (cm)	Area (km ²)	Area (%)
SLR	5	0.29	1	52	1.69	5	104	3.03	10
SLR + 100-year flood	201	5.26	17	248	6.48	21	300	7.87	25

Impacts on residential areas in Pärnu in the 'high case' scenario and a 100-year storm surge



Source: SEAREG (See www.gtk.fi/projects/seareg – accessed 19.10.2005). Contributing authors: Michael Staudt and Johannes Klein, GTK.

On the one hand, strategic proactive policies can be developed that effectively manage the threats and fully exploit the opportunities provided by the changing climate and socio-economic conditions. An alternative strategy would be a 'no strategy', where this issue is ignored. This would maximise our vulnerability to climate change. A recent European survey suggested the latter approach is the norm (Tol *et al.*, 2004), but some countries have since then developed national climate change strategies.

3.1.2 High rates of coastal development

Where the coastal strip has already been developed, a rapid process of saturation occurs. This affects not only the Mediterranean but also other coastal areas along the Atlantic, the North Sea, the southern Baltic Sea and the Black Sea.

This situation is complex due to a series of different drivers (e.g. city harbours and logistics, tourism fluxes, external and internal demand for property on the coast and land abandonment inland). Moreover, it has made the coast extremely attractive for people and leisure activities. This is a general trend for Europe, but not uniform along all coasts. Sometimes peripheral coastal regions with stagnating living standards and prevailing de-population exist back to back with highly prosperous areas. Such a dichotomy is observed between under-exploited and abandoned areas, and areas under development along the Baltic and the Atlantic coast where the population is increasing. It is also pertinent to the North Sea and the Mediterranean. Therefore, enclaves of poverty exist along the coast from the Mediterranean to the Baltic, Atlantic and Black Sea, coexisting with huge urban, residential and tourism developments.

Transformation of the coast into artificial land cover has a major impact on both the socio-economic fabric and the environment. In the past, the intensification of coastal uses was based on the conventional economic model of growth, where infrastructure development (e.g. harbours, railways and road networks) drove the coastal economy. This development attracted labour, and urbanisation followed.

Today, large parts of the coast follow a different development model based on a very high degree of land conversion to artificial surfaces. This development is often decoupled from population growth and driven by the demands of tourism; the most dynamic economic sector on the coast.

In the coastal regions of France, for instance, the tourism sector has clearly become the dominant

activity, according to analysis from IFREMER. It represents up to 44 % of the added income. Tourism adds 12 times more income than fisheries, 15 times more than harbours and 8 times more than maritime fleets (DATAR, 2004).

Coasts show a concentration of territorial occupation when compared to inland areas. In 2000 the share of area covered by artificial surfaces was 25 % higher along the coasts than in inland areas. This confirms 1990–2000 trends in European coastal zones, which show that the growth rate of artificial surfaces on the coast have grown about 1/3 faster than those inland. At the same time, the population on the coasts has only grown a 1/4 faster than total population.

Between 1995 and 2025, the projected coastal zone urbanisation on some Mediterranean coastlines shows built-up occupation increasing from 55 % to 73 % in Spain, 24 % and 34 % in France and 38 % to 45 % in Italy, respectively (Blue Plan, 2005).

This report shows that the rates of population growth are higher on coastal strips than inland and are also increasing in the coastal hinterlands (for definitions see Section 1.1). The highest population increases have taken place in Ireland, and along the Atlantic rim in France, in some coastal regions in Portugal and on the Mediterranean coast of Spain and France. A significant increase in population has also occurred around urban areas of the Baltic Sea in southern Sweden, Poland and southern Finland.

Housing, services (including tourism, commercial/logistical areas and transport infrastructures) and recreation are the main activities responsible for the process of land conversion to artificial surfaces. 61 % of all land take by artificial surfaces is due to these factors.

Many of Europe's capital cities are on or close to the coast, including Amsterdam, Athens, Copenhagen, Dublin, Helsinki, Lisbon, London, Oslo, Riga, Rome, Stockholm, Tallinn and Valetta. In total, there are about 280 coastal cities with a population above 50 000.

The predominant pattern of residential urbanisation is diffuse settlements adjacent to or disconnected from concentrated urban centres. Residential sprawl is on average responsible for more than 45 % of coastal zone land transformation into artificial surfaces. There is an increasing demand for investment in coastal residences due to tourism and leisure from northern Europe. In addition, there is also domestic demand from the inland population, e.g. the retired.

Residential expansion began in some areas of the Mediterranean regions 30 years ago (e.g. Riviera, Costa del Sol and Costa Brava). In the past 10 years this expansion has spread to the coasts of other regional seas, for example the Atlantic coast (Portugal, France, Ireland), the southern North Sea (the United Kingdom, Belgium, Denmark) and the Baltic (Estonia and Poland). Residential sprawl on coastal land is also notable around urban areas in Sweden.

The pressure on the coasts of Sweden, especially in the archipelago areas, comes mainly from the building of summer cottages. The population here is mostly seasonal. During the summer months outdoor recreation is very intensive on islands close to urban areas, for example with domestic and international tourists using recreational boats. The population in the Stockholm and Gothenburg archipelagos increases substantially during the summer months (Eionet consultation, Sweden).

As a result of a French assessment, the regulation of urban sprawl on the coast is now a priority issue. However, obtaining regulation is very difficult (DATAR, 2004). The desire to own a house or an apartment with a sea view is an extremely attractive and leads to a continuous build-up along the seashore. If left only to market forces the increased demand for coastal properties would result in rapid occupation of all available land on the coast. Planning should better regulate the sprawl of built-up areas. But in some countries local planning allows people to build anywhere. This results from the need for tax revenues. For local governments the build up is often perceived to be the only way to gain revenues for financing municipal services. Such a financial model should be reviewed in the light of spatial planning and sustainable development.

At the same time, demand for waterfront property and resulting high prices of land near the shore have made housing economically inaccessible to people permanently living by the coast. This especially affects young people and public employees, who cannot afford to live nearby. Their housing demand moves to the coastal hinterland or further inland. As a result, the social fabric of local communities deteriorates and also commuter transport demand is added.

Due to this new demand, property prices are rising in the coastal hinterland and expansion of artificial areas continues in some distance from the coastal strip. In the North Sea and the Mediterranean this process began 30 years ago. The same process has been taking place along the Atlantic coast for

15 years and is also now beginning in some parts of the southern Baltic Sea.

Residential urban sprawl is changing the patterns of mobility and lifestyles, and transforming the space of social relations. For instance, individual means of transport are needed to travel within residential quarters. It is a system which promotes dependency on the private car and the associated problems, e.g. high consumption of energy, travel time spent in traffic, noise pollution, vulnerability to accidents etc. These are all aspects that affect the daily life of local people. Moreover, there is usually unequal accessibility to places for different social classes and groups due to varying limits of mobility (Jourdan, 2003).

It is clear that access to highways has become a preferred place to locate new residential and logistical areas. Proximity to the transport network has become crucial, and accessing services, supermarkets and work places are all served by highways or specific belt roads. Therefore, transport infrastructure development is an important driver of sprawl of artificial surfaces on the coast. Today, these standard service facilities are built in many parts of Europe, not only on the coast. However, they show a higher density in narrow coastal zones.

As land is a scarce resource in coastal areas, these infrastructures have a high share of land take. The application of a similar design and style for new construction and common leisure services (aquatic parks, golf courses, cart circuits etc.) are transforming coastal areas into anonymous peri-urban landscapes devoid of any character. As a result, these areas risk losing their local identity and becoming standardised, artificial spaces for service provision.

Coastal urbanisation and urban sprawl in coastal zones is no longer necessarily induced and supported by the main coastal cities. By its nature, urban land use along the coasts has become suburban. This new phenomenon, which challenges the state of the environment and sustainability of the coastal areas, is recognised by coastal managers across Europe (CPMR, 2005).

3.1.3 Tourism development

Rapid acceleration in the use of coastal space is mostly driven by the recreation industry. Conventional tourism trends are especially well represented along the Mediterranean coast. The French Riviera has attracted tourism since the

beginning of the 20th century. Also, the Costa del Sol and Costa Brava (Spain) developed significantly during the 1950s and 1960s due to the demand for high quality holidays. This led to the combined development of accommodation, infrastructure and leisure facilities, such as golf courses and marinas.

In general, significant development has occurred over the past 20 years. The fashionability of these areas and the growth of the middle class in Europe and abroad have boosted this development. As a result, rapid growth has occurred. This development sprawls to the south and south-eastern Mediterranean, creating a 'Med wall' with 'more than 50 % dominance of concrete along the coast' (UNEP/EEA, 2005). In the last 10 years, the Mediterranean urban tourism model has been mirrored in many other coastal areas in Europe, such as Brittany, the south Baltic and around the Black Sea.

Northern European cities now emulate the south with bars, cafes, restaurants and outdoor terraces (e.g. coastal urban and harbour restructuring in Stockholm, Gdansk and Hamburg). However, the Mediterranean continues to be the major attraction. Sun, urban beaches and lower prices, especially for food and wine, are the key reasons for the continuous pressure being put on the Mediterranean.

In addition, growth in short-break holidays is taking place. Low fare airlines can take people to

Mediterranean resorts at rates cheaper than ever before, which adds to the already huge amount of air passenger traffic.

At the same time, other new European destinations represent competition to the more established and saturated Spanish, Italian and French Mediterranean destinations. These new destinations should be viewed more as an opportunity than a threat as they help to de-concentrate the southern coasts. Most of these new coastal destinations are accessible by low cost flights to secondary and regional airports all along Europe's coasts.

These airport infrastructures should also be valued for their economic activity and jobs. The concerned regions are generally very open and positive to airport construction, especially in less favoured areas. Several studies highlight the benefits of low fare airports to regional airports and regions (European Low Fares Airlines Association⁽¹¹⁾). These studies emphasise the increases in tourism, employment and influx of businesses to the region which have resulted from the increased number of destinations offered by airports. Airports like Charleroi, Frankfurt Hahn and many others are located in underdeveloped regions, many of which lie on the coasts. The growth of the airport has facilitated regional regeneration.

Too often new holiday destinations along the coasts of new Member States or accession countries develop according to the same intensive tourism

Box 13 Case study: the Maltese Islands

At European level it is difficult to see the growth in built up areas that Malta has experienced so far. This suggests that the Maltese coast is not under too much pressure, and sends the wrong message that further artificialisation and urbanisation of the coast can continue. There is however significant development pressure on the coast which is threatening not only the physical environment but also leading to conflicts amongst its users.

Malta has been a tourist destination since 1960s and is now looking to be more competitive in the face of new destinations with fresher appeal and more territories. The Maltese islands have promoted the coastal environment as a main tourist attraction and subsequently the measures taken over the years to build up a strong tourism industry have been directed towards coastal development. Tourism infrastructure related to the coast is mainly associated with the availability of accommodation in terms of hotels and holiday apartments. The trend for developing coastal areas for tourism accommodation has eaten up extensive areas that were previously used or could have been promoted for recreational purposes, e.g. walking or bathing. This trend has undermined the available space for informal recreation, even for visiting tourists, and is an issue on an island where the only open space is the coastal environment (MEPA, 2002).

Source: MEPA (See www.mepa.org.mt/index.htm?spr/topics_coastal.htm&l — accessed 08.06.2005) (Coastal Strategy, Topic Paper 2002).

⁽¹¹⁾ www.elfaa.com/publications.htm — accessed 20.01.2005.

model. In many places, the coastal resources and landscapes are of very high natural value. This is the case, for instance, on the coastlines of Croatia and Turkey as well as on some small islands like Malta. Achieving an equilibrium between local development, habitat protection and landscape quality is the key to the sustainable future of these new coastal destinations. This is a clear recommendation to be taken into account by policy makers, especially for the ICZM.

Domestic tourism grows practically at the same rate as international tourism on the coasts of western Europe. The growth in GDP has given rise to a middle class buying second homes or using a significant portion of their disposable income on short breaks in Europe. There has been a boom in demand for country houses and summer cottages because they are a good investment and offer new holiday opportunities for families.

Other forms of tourism or leisure, both national and international, are also gaining momentum. These forms include cultural activities such as the wine-tasting, gastronomy, pilgrimages, health, ornithology and photography.

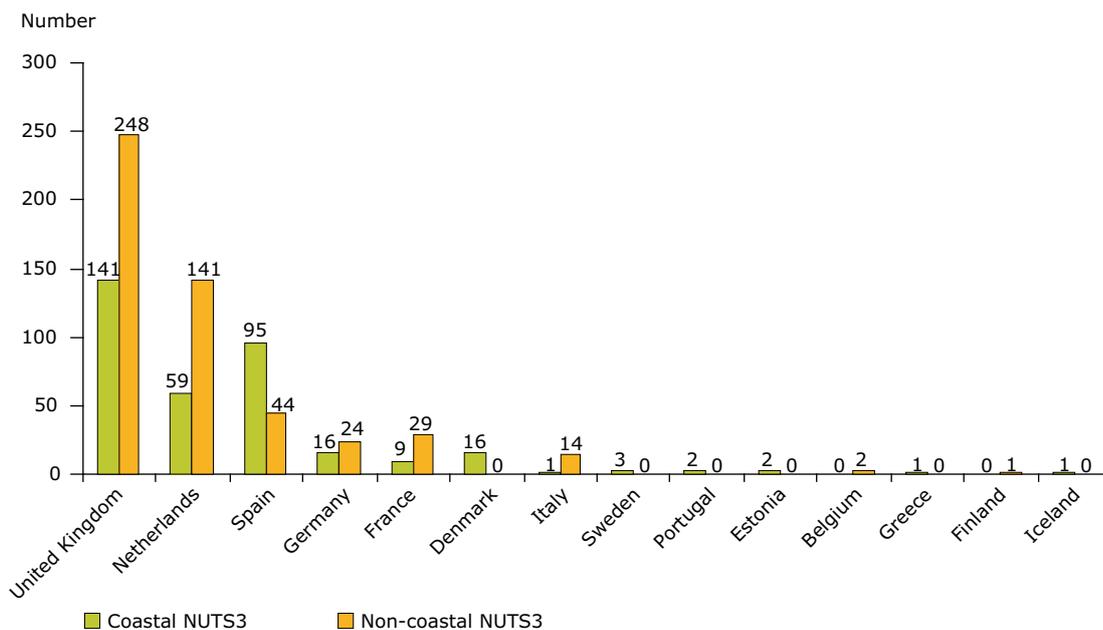
These more specialised forms of tourism and leisure activities are not as intensive as mass tourism and provide more stable economic returns to local

communities. Moreover, they better respect the local culture and landscapes and help people experience other European cultures. In general, they are more oriented towards natural and cultural heritage. Development of this kind of tourism can prove to be more sustainable for coastal landscapes in the long term.

'Sustainable tourism', 'eco-tourism' and 'green tourism' have been promoted over the past decade as ways of obtaining environmental benefits from tourism while at the same time providing much needed jobs and social investment. Counting the amount of tourist accommodation which qualifies for an eco-label is a crude yet relatively easy way to measure current progress towards greater sustainability. Unfortunately, only a small number of eco-labelling schemes are independently assessed, and hence claims about environmentally friendly goods and services must be treated cautiously (DEDUCE project).

In some coastal regions important navigation and boating traditions are key. For example, sailing schools have been active for many years in Brittany and La Rochelle in France, the United Kingdom, Denmark, Sweden, Finland and Norway. In Sweden sail boats are used very intensively amongst the archipelagos islands. It is often a sustainable way for transport to travel from Stockholm to small cottages near the coast or to visit different islands. In Spain,

Figure 15 Eco-labelled tourist accommodation in coastal and non-coastal NUTS3 regions (2005)



Source: EEA, 2005, based on data from Eco-label link (See www.eco-label-tourism.com — accessed 16.10.2005), Emas link (See www.eu.int/comm/environment/emas/index_en.htm — accessed 18.10.2005) and Yourvisit link (See www.yourvisit.info/index_gb.html — accessed 19.10.2005).

this tradition is not as old, and has only recently started to gain momentum. With the exception of boat enthusiasts, newly built marinas and enlarged old marinas serve more as status symbols and garages for boats. The function of marinas in southern Europe is related more to a demand from a growing middle class than a maritime culture.

Maritime archaeology is increasingly becoming popular. The potential for developing this activity is great and the opportunity to use it as a positive recreational resource is significant. However, assessment and control are required.

Tourism creates significant pressures on coastal water resources. For example, demand for water in Malta doubles during the tourist season, while on the Greek island of Patmos it increases sevenfold. Many regions, including Spanish resorts and Malta, are running out of water and are resorting to investment in the desalination of sea water (EEA, 2005). Pressure on water resources, climate change and an increased need for air conditioning in tourism related facilities put greater demands on the coast.

Another pressure coming from the leisure and tourism industry is the golf course. The construction of numerous golf courses along the coast and the associated urban development, exacerbates property speculation (e.g. in Algarve, Portugal, in Spain and Italy). Golf courses are important consumers

of herbicides, nitrates and water, especially in the south where it is difficult for grass to grow without these inputs. Even though golf courses may be more aesthetically pleasing and blend in with the landscape, they represent a simplification of the ecosystem (except in the case where local vegetation is respected).

The ageing EU population has led to new emerging trends, such as a high demand for houses in regions where people's family roots lie (e.g. Brittany in France). This situation is exacerbated by retired people from northern Europe moving to the south. As a result, these places have special facilities, such as hotels specialised in providing leisure activities for retired persons (e.g. excursions, sport, dance and cinema).

All these developments are approved and even promoted in most regional planning, as the market economy is prioritised over environmental concerns. Planning objectives are too often focused on satisfying demand of private needs instead of managing demand, bringing more quality activities and adding value to the region. Good short-term returns on private investments are too often prioritised. This has a tremendous impact on common natural resources and the local socio-cultural fabric in the long-term.

Coastal development and tourism intensification are leading to the over frequentation of natural sites both on land and at sea. This is a main issue in areas

Box 14 Impact of marinas on the European coast

Yacht harbours have a serious negative impact on the environment due to the consumption of land, degradation of surrounding shallow waters, disturbance of the dynamics of coastal currents and chemical pollution, according to the Blue Plan.

Marinas have serious externalities as they constitute barriers for littoral drift. They also retain the sediments upstream, which induces significant local erosion down drift. Even boats that only go out 3–4 days per year disturb habitats which are inaccessible by other means, e.g. rocky coves. Damage can be done to these areas in a variety of ways. For example, anchor impacts on sea-grasses.

These activities are very important along the Mediterranean coast. For example, 250 000 supplementary moorings would satisfy the demand on the French Mediterranean coast; a demand which has grown from 1.5 to 2.6 % per year in the French Mediterranean coast (AFIT, 2003). Moreover, marinas are developing quickly in new Member States, such as Malta or Croatia. Boating has also major implications for the terrestrial coast, as infrastructures are built to keep boats out of the water. These dry harbours add to the artificialisation of the coast.

Source: Blue Plan, 2005.

Other negative impacts of boating reported in Sweden and other places include disturbances due to boat bottom colour, noise, and wear and tear. Anchorage, waste and illegal sub aquatic fishing are another typology of the widespread problems associated with recreational boating (Eionet consultation, Sweden).

with high value ecosystems. Frequentation of a high number of people impacts on fragile coastal systems. This is exacerbated by new motorised forms of leisure (e.g. all-terrain vehicles, mopeds, scooters) which are more destructive when used on dunes, lidos and forest paths. Erosion, distressing animals and other impacts are the results of these activities. It is worth noting that 90 % of forest fires are caused by man. Diving activities without control can also deeply alter underwater ecosystems, especially when coupled with illegal gathering of coral or catches of fish.

These impacts create many externalities that ultimately local communities have to pay for. Integrated management and planning of the coast should try to regulate the failures of the market. It should also promote policies to internalise externalities. For example, sand volumes extracted during construction of a marina could be replaced by developers following the criteria of the Strategic Environmental Assessment. For example, a pool of public land could be created to allow protection and low cost housing policies could be devised. Urgent work needs to be dedicated to these topics and also to the applicability of eco-taxes as a financing source.

3.1.4 Agriculture

Agriculture is a significant, albeit declining, source of employment on the EU's coasts. This activity has been very important historically in coastal areas, and has often been coupled with fishing activities. Nowadays, agriculture in coastal areas continues to be extremely relevant because it plays an essential role for production, supporting the multi-functionality of coastal areas. It also has a crucial role in the maintenance of coastal rural landscapes and the conservation of biodiversity. Landscape management introduces many opportunities for tourism activities, local employment and the fresh food market.

Understanding the specifics of coastal agriculture and its evolution is critical. The vast heritage and traditional practices in rural areas have often provided the best examples of true sustainable development. Complex analysis of these territories and activities is of paramount importance to understanding the relevance of the sector in the wider context of coastal land use. This importance is reflected by the level of funding ascribed to the areas by the EU.

Agriculture areas are shrinking as a result of farmland abandonment. This gives rise and

affords area for afforestation. Coastal agriculture also suffers important urban pressures. Almost 2 000 km² of agricultural lands were lost in all coastal zones, at various rates in different European coastal countries between 1990 and 2000. On the Mediterranean coast, important internal changes are on-going as extensive agriculture is replaced by intensive agriculture in, for example, Almería or Levante in Spain and the southern regions of Italy, Greece and Cyprus.

General problems found within the EU's territory (e.g. a decrease in the number of farmers, ageing farming communities, lack of continuity and increasing of land prices) are often much more intense along the coast. In France, an indicator has been developed to assess the vulnerability of farms in social and economic terms (IFEN, 2005). Conditions differ along the coast, and there are clear contrasts between areas where agriculture prospers and where it does not (see Box 15).

Areas of mixed farming, pasture and wetlands promote more biodiversity and also maintain traditional practices as part of coastal management. The disappearance of these practices also represents a loss of cultural heritage (e.g. specific knowledge on soil management, loss of traditional products and landscape transformation). Moreover, a number of practices including the management of periodically flooded meadows happens to be excellent adaptive action against flooding and produces good quality milk and meat. These practices are relevant in the United Kingdom, France and Spain, for instance.

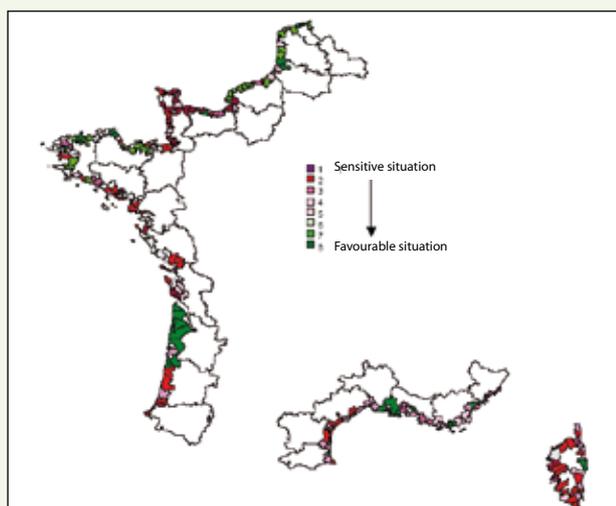
Market forces (e.g. land prices, specific demand and high investments), the regulation of certain agriculture sectors (milk, olive oil production and dry fruits etc.) and practices (e.g. set-aside intensification) are drivers of agricultural change on the coast. In areas where agricultural production produces benefits, e.g. in high quality wine production areas, landscapes are fairly well maintained. The region of Penedés, Spain remains predominantly agricultural despite urban pressures from Barcelona and the coastal location. This also prevents urban sprawl moving into the coastal hinterland.

Agricultural areas strong enough to resist urban pressures are those that provide high revenue. Therefore, the most intensive agriculture (e.g. flowers, seeds, fresh vegetables, 'primeurs') is located on the coast. This type of agriculture also demands natural resources often found on the coast, such as sandy soils, groundwater and long periods of sunshine throughout the year. Intensive

Box 15 Agriculture on the French coast

In France a correlation exists between the type of agriculture on the coast and the orientation of production. More fragile farming exists within areas of extensive animal production (e.g. Manche, Basque Country, Corsica) or areas of viticulture without AOC (Appellation d'Origine Contrôlée) (Hérault). The more prosperous farming sectors are those dedicated to intensive monoculture (Nord-Pas de Calais, Seine Maritime), intensive pig farming (Brittany) or cultures with high added-value (e.g. high quality wines in Bordeaux region and Var, flower cultures in the Cote d'Azur, and horticulture in Corsica). To summarise, agriculture is less prosperous in rural areas where mixed farming and pastures are dominant, such as along the coasts of lower Normandy, Corsica and the Atlantic wetlands areas. Other farms in a similar precarious state are also located in urbanised and/or tourist areas where land prices are high, e.g. south of Charente Maritime, sud Aquitaine, Languedoc-Roussillon and PACA coastal areas.

Socio-economic typology of agricultural farms in the French coast



Source: IFEN, 2005.

agriculture and greenhouses, which are typical of the Mediterranean coast, represent controversial forms of agriculture because they are often considered as intensive as industrial activity.

Conversion to artificial land cover is sealing fertile coastal soils in Europe, especially along the coasts of the Mediterranean, Portugal and the North Sea. This is either occurring in an irreversible way or is very costly to reverse. Moreover, it spoils

good agricultural soils for centuries. The sealing of soil often affects areas of water recharge for groundwater reservoirs and also areas vulnerable to flooding or coastal erosion. As a result, this increases the vulnerability of settlements.

In Mediterranean areas, it is estimated that agriculture uses around 80 % of the available water resources. Water shortages, especially during summer months, make the building of new

Box 16 Urban wastewater recuperation in Empuriabrava

As water is scarce in summer, conflicts develop between agriculture and the tourism industry. In Europe's biggest marina, Empuriabrava, conflicts have been transformed into opportunities. A specific system of recuperation of urban wastewater of the 90 000 people living in the resort in summer has been put in place with the help of EU funds. After secondary treatment, wastewater is sent to a lagoon system with vegetation filters and is then used to maintain the water level of certain wetlands. These wetlands are the only ones with water during the dry season. As a result, this action creates both specific habitats for birds and resources for environmental education which tourists can enjoy.

Source: Baradad i Baldomà, O., 2004.

Box 17 Llobregat's delta agricultural park

Agricultural parks protect land from urban sprawl. Moreover, they promote agriculture to young people with a view to keeping them within the sector and managing the environment. In the Llobregat delta, Barcelona water is obtained through a very special system. Once treated in the huge new wastewater plant at the mouth of the river, water is pumped up the hill, and fed down irrigation channels. This practice helps avoid the direct loss of treated water into the sea. Moreover, when coupled with an environmentally friendly system of production it integrates new forms of pest and nutrients control. This lowers nitrate release into surface waters. In addition, the treated water ensures a good water level in the nearby lagoons and other wetlands of the delta. The practice is also used to recharge the underground water reservoir. Producers are organised within an agricultural park. They take advantage of the proximity of the city to sell directly their horticulture production, which provides an opportunity for consumers to get fresh, quality produce.

Source: ETC-TE expert judgment based on: Breton, F.; Tulla, A.F.; Sempere, J.; 2001.

Box 18 Restoring a multi-functional rural economy in the Väinameri coastal region

A project has been implemented in the Väinameri coastal region in western Estonia to return the area to a multifunctional landscape after a Soviet legacy of large scale, specialised, collective production. The project brought back extensive agriculture, based on high natural values, optimal grazing of coastal meadows and low use of artificial fertilisers and chemical. At the same time, other actions were proposed in the region for non-agricultural sectors to use the area's nature and culture as base for production. Rural tourism, handicrafts, bio-energy and local fisheries have developed which are bringing important complementary revenue sources and employment opportunities. As a result, the natural value of the area looks likely to be maintained in the long term.

Source: Kokovkin, 2005.

desalination plants along the coasts necessary. Most of the water from these plants goes to agriculture. The impact of these installations includes the local concentration of salt in coastal waters, which threatens underwater biotopes, and the emission of carbon dioxide.

Sustainable agriculture helps to balance areas (i.e. as a buffer against urbanisation, landscape management, multi-functionality instead of a tourism monoculture) and manage soils, climate, hydrological conditions, traditional products and genetic assets. It also helps local communities retain traditional knowledge. Emergent trends point to the importance of agriculture as a support for new forms of tourism and leisure. Furthermore, it facilitates and promotes educational activities which focus on the area and its ecosystems.

Some initiatives have had a positive result. The development of agri-environmental operations in France, implemented under Regulation 2078/92, had a strong ecological dimension. For example, the overall impact of 20 programmes targeting the coastal marshes has been positive. Improvements in the management of threatened natural pastures

has taken place, and marshland biodiversity, especially the general habitat type, has benefited (EEA, 1999b).

Another positive trend is organic farming, which represented 1 % of agricultural holdings in 1996, and has grown considerably. For example, in Sweden it grew from less than 10 000 ha to more than 160 000 ha between 1985 and 1996 (Eurostat, 1998). Since 1998 the share of arable soils under organic farming has doubled to 3.8 million ha. A significant part of this surface represents the agriculture on the coasts and archipelagos islands. Taking into account these figures, Sweden has one of the highest shares of organic farming among the coastal countries of Europe (EEA, 2005).

3.1.5 Industry and energy production

Many industries are located on the coast since their activity is strongly linked to the sea. The sea is the main transport route for certain goods, like oil, and harbours and rivers are also important transport hubs.

Coastal industries are mainly related to the maritime sector, such as shipbuilding. These coastal activities are important in the Atlantic (e.g. St. Nazaire, France; Bilbao and Cadiz, Spain), the North Sea (e.g. Belfast and others in the United Kingdom), and the Baltic Sea (e.g. Gdansk, Poland). Competition resulting from globalisation has led to economic decline and the moving of these activities to other countries. This has led to significant structural unemployment and other socio-economic problems in coastal regions. As a result, these situations need to receive specific attention in different coastal areas. The new aid framework for shipbuilding, which came into force on 1 January 2004, was a step forward as it made this sector eligible for aid for innovation (CPRM Expert comment). For example the Gdansk area in Poland has taken a new strategic line oriented towards urban renovation, based on its cultural heritage, and supported by the construction of a new dynamic airport. Now, the city is an upcoming tourist destination in Europe. Urban tourism is often a very convenient response to economic problems and unemployment in traditional industries. However, it must be planned in a sustainable way, so that it avoids the growth in urban sprawl.

Coastal industries are becoming more and more linked to the harbour functions of logistics and 'just in time' working practices. These services are located in areas served by highways and within easy reach of the main harbours. They depend on harbours for both receiving pre-assembled components from Asia, and for easy export of finished products to other markets.

The relationship between industry and harbour activities is becoming more critical. The main harbours have been restructured and enlarged to serve the new needs of these industries. Investment in harbours has been crucial for the development of harbour-cities and regional hinterlands. Competition between them has been very fierce, as attracting multi-national shipping companies is the key to becoming a multi-mode hub and a main door for European industries and markets. Competition has occurred between Rotterdam and Antwerp, St. Nazaire and Nantes and Genova, Marseilles and Barcelona. Sustainable development of these port areas is urgent. The development of all existing ports is neither desirable in terms of environment and landscape conservation nor is it economically realistic (CPMR, September 2005).

Therefore, more precise and better enforced planning of harbours is needed at EU level. This should present an alternative to current laissez-

faire market forces, and offer a rational network of harbours well connected with multimode links to their hinterlands (Eionet consultation, DG ENV). This planning should be integrated with the issue of environmental conservation, most notably under Natura2000 network, when land is needed to extend port areas (CPMR, September 2005).

Energy demand is increasing in coastal areas because of the concentration of industries, population and tourism. Located offshore, oil extraction platforms and related services provide a living in some coastal regions, especially in the North Sea. Aberdeen is a city whose economic development has been closely linked to the oil industry. However, this activity has important environmental consequences.

Oil refining has also been associated with harbours, where the direct arrival of pipelines and oil tankers from oil extraction sites make the transfer between transportation modes easier. Marseille/Fos in France and Huelva and Algeciras in Spain have significant refinery infrastructures.

The more polluting processes of oil transformation have been re-located to countries where pollution control is less stringent. This explains the level of tanker traffic on European seas. The tankers are loaded with heavy oil products to be processed outside Europe. This increases the risk of spills, which are becoming the biggest accidental threat to coastal ecosystems.

New oil terminals and petro-chemical processing plants located on the coast use more space. For example, the recent development of large oil terminals on the eastern coast of the Gulf of Finland.

The retention of water related to dams for hydro energy production is also an important issue. Practically all European rivers are affected by some kind of dam. Dams may threaten minimum ecological water flow to support river ecosystems, stop animals moving within their habitats, and trap and prevent sediments from reaching the coasts.

The generation of green energies has increased due to higher demands. Solar installations generally need less space and are more flexible in terms of their location compared to wind turbines. So far, the latter are concentrated in north-western Europe and have started to claim a noticeable share of coastal space. There are much less wind turbines on the Mediterranean coast, but the installation of wind generators is likely to increase in the near future.

The best coastal and offshore locations for wind farms are found where the wind is strong and reliable, such as in Spain (Tarifa), the United Kingdom (Cornwall and Wales) Denmark, Ireland, Netherlands and Belgium. For example, in Tarifa (Spain) more than 5 000 wind turbines have been installed; all of which lie within 10 km of the coastline (Andalusian Ministry of Public Works and Transportation). The prerequisites for offshore wind energy farms in the Baltic Sea are good and there are currently several new applications under scrutiny in the southern part of the Baltic Sea (Eionet consultation, Sweden).

There is increasing awareness on the potential of electromagnetic pollution derived from high voltage power lines. This issue can be of relevance in some coastal sites where the territorial pattern of infrastructure is highly linear and urbanised.

Besides helping to reduce the EU's dependence on environmentally harmful fossil energies, the development of renewable energies offer significant economic potential. In coastal areas however, wind energy, wave power, tides and currents energy can pose problems come into competition with other economic or leisure-based activities and the protection of ecosystems (CPMR, 2005).

Although green energy can satisfy the huge energy demand on the coast and help bring additional incomes to coastal communities, it is still not sufficient to cover all power needs. Energy demand on the coast is rapidly increasing.

3.1.6 Fisheries and aquaculture

Historically, fishing has been the coastal activity 'par excellence'. However, during the last decade the

sector has experienced a serious structural crisis due to over-fishing and stock collapse. The disastrous state of the more valuable demersal stocks demands immediate action, as those species in serious decline need a chance to rebuild. In addition, there are other options available such as the adoption of technical conservation measures (e.g. through net sizes and the establishment of recovery plans; Eionet consultation, Denmark). Over past decades the fishery sector in Europe has been affected by changes aimed at making conservation of sea resources a priority objective.

In 2002 the EU-25 produced nearly 7.6 million tonnes of fishing produce. This figure represents about 5 % of the world total. Between 1995 and 2002 EU-25 production fell by 17 %, while world production rose by 17 %. Not only have landings declined, the average trophic level of landings has fallen (MEA, 2005a). This phenomenon, also known as 'fishing down the food web' means that high value top-predator fish are being replaced in catches by smaller, less preferred species. The number of species that continuously retain commercial value is also declining. In the Black Sea, the species regularly caught in nets have fallen from 27 to 6 (EEA, 2005b). The mean size of caught fish is diminishing for many species. By-catching under-sized or non-targeted, non-commercial species remains a problem and the discard rates are high. For example, by-catches represent 22 % of landings on average for the North Sea (EEA, 2005b). Fishing and other environmental damage provides ecological 'space' for new invasive species. The existing food webs in marine ecosystems may also be impacted upon by fishing pressure on small abundant fish species, like sand eels in the north-east Atlantic or capelins in Barents sea. These species are used mostly for aquaculture fishmeal.

Reducing the fishing effort and fleet size inevitably lead to job losses. Between 1990 and 1998, employment in the sector in the EU fell by about 66 000 to 241 000. This corresponds to an overall decrease of 21 %. The last decade has seen a net reduction in employment of about 8 000 in the sector each year (Eurostat, 2003). The processing sector has also seen a 14 % decline in employment (EEA, 2005b).

The fall in fishing output and the reduction of the fishing effort mentioned above is relevant for both coastal and offshore fisheries. The problems with coastal fisheries are much worse. Moreover, they are exacerbated by the fact that there is no distinction between coastal and offshore fisheries. A distinction needs to be made. Data management

Map 16 Night glow as indication of human settlement distribution and related energy use



Source: DMSP/OLS (NASA) image, 1994–1995.

requirements currently in place mean that fisheries as a whole must always be considered (Eionet consultations, Denmark and Ireland).

The development model which tries to avoid competition between different uses of the coast increasingly threatens the continuation of small-scale coastal fishing. Coastal fishery rarely wins when options for sectoral priorities are considered, especially when there are conflicting interests. On the basis of access to resources, the conflict of interests may also occur between small-scale coastal fisheries and commercial fishing enterprises.

Following integrated coastal zone management principles, it is thus important to find the way to promote a coastal fisheries model and offer local fishing communities the opportunity of collaboration on a framework for the integrated management of coastal resources. They need support for structural change towards alternative practices (e.g. sustainable aquaculture). Following the convergence objective of the EU cohesion policies, this would also enable local communities to continue living in the area (CPMR, 2005).

Aquaculture has developed at a time when the fishing of wild fish has declined. Importantly, it provides an alternative way for fishing communities to make a living with new technology, namely, fish farming. Along with this trend, another change has taken place. There have been a move away from 'fish for food' to 'food for fish', e.g. feed for aquaculture fish. Therefore, a large section of the fishery industry now serves the aquaculture sector.

In recent years, aquaculture has been the only segment of the fisheries industry in the European Community to experience a rise in employment. It now accounts for approximately 60 000 full-time jobs, mostly in rural and coastal areas (EEA/UNEP, 2006). The total number of jobs gained in aquaculture are fairly consistent with the number of jobs lost within fisheries. More insight should be given to see if this shift is true in all places and if aquaculture is a real alternative to the fishing industry for coastal communities. Despite these figures in employment, fishing wild fish provides four times as many jobs as aquaculture (Eurostat, 2005).

Aquaculture is very controversial because it brings problems to the local environment. For example, aquaculture farms make intensive use of coastal zones (e.g. estuaries, bays) without considering the equilibrium and resilience of coastal and marine ecosystems.

Nevertheless, conflict with surrounding areas can be controlled using isolated production sites. The EU's fishery funds (axis 3) aim to promote aquaculture which is environmentally and socially sustainable, and which offers a high quality product.

It has been estimated (EEA CSI 33, EEA⁽¹²⁾) that salmon fish farming in Nordic countries releases nitrogen in quantities equivalent to the sewage of 3.9 million people. This can cause water eutrophication especially in estuaries or in coastal waters around the installations. At the same time, following the Water Police Initiative of the Government of Andalusia, aquaculture installations

Box 19 Reducing fish catches and the fishing fleet

Between 1995 and 2002 nearly all Member States reported falls in fish catches. The largest decreases over this period were registered by Denmark (- 28 %), Spain (- 18 %), Poland (- 44 %) and Italy (- 26 %), as listed in total tonnage. In 2002, total catches from all regions accounted for 83 % of EU-15 and AC-10 (now EU-10) fisheries production. Catches in the North-East Atlantic alone represented 4.62 million tonnes, and made up more than 60 % of total EU-15 and AC-10 production. Catches in the eastern and central Atlantic, and the Mediterranean accounted for 8 % and 7 %, respectively.

Between 1995 and 2003, the EU-15 fishing fleet fell by 15 % from 104 000 to 88 000 vessels. All EU-15 Member States recorded a fall in the size of their fleets over this period, except France, which rose by 1 500 vessels. The largest falls were of 3-4 thousand vessels which were registered in Spain, Italy and the United Kingdom. Total tonnage only declined by 4 % between 1995 and 2003 to 1.9 million tonnes. By far the largest fall was registered in Spain, and the largest rises were recorded in France and Ireland.

Source: Eurostat (See http://epp.eurostat.cec.eu.int/pls/portal/docs/page/pgp_prd_cat_prerel/pge_cat_prerel_year_2005/pge_cat_prerel_year_2005_month_01/5-11012005-en-ap.pdf, accessed 22.11.2005).

⁽¹²⁾ www.eea.eu.int — accessed 23.11.2005.

in Huelva, the Bay of Cádiz, Málaga and Granada are controlled and respect the proposed water quality values in the water framework directive.

As coastal waters play an important role for fish nursery habitat, eutrophication due to cultivated fish leads to the loss of habitat for wild fish. There is a serious need for mapping fish habitats and their importance for different stocks, and for devising ways of managing them in order to preserve important nursery grounds (Eionet consultation, Finland).

However, it should be highlighted that the water framework directive is currently in its implementation phase. The first steps include identifying the location of all the aquaculture facilities and controlling their wastewater. This will afford information on their effects on the coastal and marine environment. In Spain results of such work have been reasonably successful (Andalusian Ministry of the Environment ⁽¹³⁾). WFD should also help simplify rules and regulations concerning the land-sea interface, which are increasingly complex (CPMR expert consultation).

Other important impacts of aquaculture on the marine environment include:

- the potential risk of escaped farmed fish on the genetic integrity of wild fish;
- the spread of disease and parasite infestation;
- increased inputs of veterinary drugs for growth and disease control, such as chemical disinfectants and antifouling agents to coastal waters (Eionet consultation, Norway).

Moreover, in many places, aquaculture is identified as one of the major causes of alien species introduction, which has a strong impact on the local eco-system and biodiversity (EEA/UNEP, 2006).

Fishing communities will gain from aquaculture only in some areas. In other areas, especially where small-scale, coastal fisheries are relatively strong, there is the risk of conflict between both activities, as both take place in the same coastal space. This leads to the need for new measures for sea use planning; new measures which are still underdeveloped in most territorial waters of the EU. It also poses the issue that collaboration gives better results than competition. In some cases, such as Greece, Turkey or Spain, aquaculture coexists in harmony with traditional

fisheries, especially where aquaculture is based on protected and over-exploited species (e.g. grouper, tuna), whose capture from the wild is restricted (EEA/ETC-W, 2005).

Fishing communities should be able to access specific training programmes to facilitate their integration into the management of a changing environment. Accordingly, fishing communities in coastal areas are increasingly called upon for vital support personnel during responses to maritime disasters, environmental accidents and natural hazards originating from the sea (e.g. oil spills) (CPMR, September 2005). The EU has an intensive policy to support re-training programmes for people formerly employed in the fishing industry (IFOP ⁽¹⁴⁾).

Fishery and aquaculture policies should be conciliated with the EU Strategy for marine environment and with sustainable development strategies for the coast and the sea, including the EU's ICZM Recommendation.

3.1.7 Transport

Traditionally, flat coastal plains have been a natural option for communication. In the last 30 years, they have been a place for highways and the development of railways linking harbours with coastal cities and their hinterland.

Linear infrastructures, such as motorways, roads and railways occupy long stretches of coastal land. They form physical barriers to hydrodynamics processes and to sediment. This leads to the creation of new areas prone to flood risk. They are also responsible for coastal erosion when constructed along coastlines, dune fields or on wetlands, as they inhibit the natural processes of beach formation. In the most critical locations, erosion can lead to the destruction of the transport infrastructure itself (e.g. Isle of Wight in the United Kingdom etc.).

Moreover, roads, railway tracks and paved surfaces interrupt the water cycle by sealing the soil, preventing rainwater from permeating the ground and impeding aquifer recharge. They have additional effects on ecosystems as they lead to fragmentation and/or isolation of habitats, and impact through airborne pollutants on the surface and coastal waters. Road run-off (i.e. diffuse pollution) that occurs in coastal zones and in

⁽¹³⁾ www.juntadeandalucia.es/medioambiente/site/aplica/medioambiente/site/web/menuitem.48ed6f0384107256b935619561525ea0/?vgnnextoid=72c01efbae625010VgnVCM1000000624e50aRCRD — accessed 21.01.2005.

⁽¹⁴⁾ www.europa.eu.int/scadplus/leg/es/lvb/l60017.htm — accessed 13.04.2005.

draining catchments causes chronic pollution from contaminants, such as polyaromatic hydrocarbons, especially in estuaries and coastal waters. These trends greatly affect the quality of life of people by affecting health and safety.

Even if transport externalities are recognised, dominant practices oriented towards regional development continue to be based on the building of transport infrastructures. This tends to trigger the development of peripheral regions. Coastal regions have received substantial assistance — mainly for infrastructure investment — from the EU Structural and Cohesion Funds. For example, nearly 70 % of the EU Structural Funds for the period 1994–1999 were allocated to EU coastal regions (including nearly all EU Mediterranean areas, the Atlantic coast of Portugal, Spain and France and half of the United Kingdom's coast) (EEA, 1999a).

It is apparent that regions which have received EU funds show major trends in transport infrastructure and built up expansion during the period (e.g. Spain, Portugal and Ireland). This trend is likely to continue in the period 2007–2013 with the new Structural Funds, if they continue to focus on infrastructural development. This will particularly affect new Member States and also Mediterranean regions.

Transportation has always been closely linked with production. Therefore, the re-location or closure of traditional metal processing and the shipbuilding industry, e.g. in Balboa (Spain) or some harbour cities in the Baltic region of Germany, has led to a reshaping of harbours and affected marine transportation.

Europe has around 1 200 maritime ports which handle about 1 billion tons of cargo per year and provide transit for 300 million passengers annually. The EU merchant fleet is the world leader both in terms of tonnage and by flag, especially within the container ship category. Marine transport was a key priority in the White Paper on European transport policy for 2010. About 90 % of the EU's external trade is shipped by sea. Changes in global trade are causing increased intensity and change in the geography of sea-based transfers. This should be addressed from the perspective of the EU's economic independence.

Short-sea shipping has become extremely important in the European Union and grew by approximately

third between 1991 and 2000. Sea transport shows an ascending trend with clear growth comparable today with road transport. Marine transport represents the best alternative to road transport for a significant proportion of intra-European trade. The volume of sea transport is expected to increase further due to new concepts, such as Motorways of the Sea ⁽¹⁵⁾ ⁽¹⁶⁾. The MoS initiative has a positive role to play in the development of a trans-European multi-modal transport scheme and would support the modernisation and renovation of key port areas. However, it will also increase vessel traffic on the coastal sea routes such as Ireland-Spain, southern France-Italy, Baltic states-northern Germany and other MoS route proposals. Therefore, careful planning of marine safety and environmental measures will be needed.

Shipping in the Baltic and North Seas is already very intensive, and Sweden is one of the leading countries responding to the level of sea traffic. It enforces safe shipping regulation and takes action on environment quality objectives within the sector (Eionet consultation, Sweden). The United Kingdom has recently announced that 32 areas (9 % of its coastline) are now deemed 'high risk marine environmental areas' (MEHRA). They have requested that ships use an even higher degree of care than usual and encourage vessels to choose other sea routes (UK Department of Transport ⁽¹⁷⁾).

In recent years, Europe has suffered important catastrophes related to maritime transportation safety, e.g. the *Erika* in France or the *Prestige* in Spain and France. These are examples of catastrophes that could have been avoided. However, they did speed up new legislation to avoid further disasters. After the disasters, beaches, rocks and the seabed were cleaned up, some species do return. Nevertheless, the ecosystem takes a long time to fully recover (Eionet consultation, France). Sometimes even small spills can cause serious damage, if the weather conditions restrict optimal counter-action. For example, freezing temperatures and icy conditions meant that a relatively small oil spill in north-west Estonia created damage to several thousands of sea birds and other animals in January and February 2006 (MoE ⁽¹⁸⁾).

Safety, waste dumping and oil spill issues that arise because of the expansion of maritime transport

⁽¹⁵⁾ http://europa.eu.int/comm/transport/intermodality/motorways_sea/doc/2006_motorways_sea_brochure_en.pdf — accessed 03.02.2006.

⁽¹⁶⁾ www.worldcargonews.com/htm/ex20040525.696229.htm — accessed 20.07.2005.

⁽¹⁷⁾ www.dft.gov.uk/stellent/groups/dft_shipping/documents/page/dft_shipping_611167.hcsp — accessed 19.02.2006.

⁽¹⁸⁾ www.envir.ee/137996 — accessed 01.03.2006.

still remain a threat to the coastal population and biodiversity. More effort is needed to reduce the pollution threat, assure the protection of coastal habitats and facilitate recovery after accidents.

On a positive note, the 1996 Protocol to the UN Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972) entered into force on 24 March 2006. The Protocol represents a major change of approach in regulating the use of the sea as a depository for waste materials. Now dumping is prohibited, except for materials from an approved list, e.g. sewage sludge, fish waste, vessels, inert geological material and bulky items containing iron, steel or concrete. This contrasts sharply with the 1972 Convention which permitted dumping of waste at sea, except for those materials on a banned list.

Nevertheless, maritime traffic is causing direct environmental pollution. Issues include sea litter and air pollution from vessel engines (most notably emissions of SO₂). Problems in harbours are related to the collection of growing waste volumes from ships, such as oily waste, noxious liquid substances, sewage and garbage. These groups are all specified in sub-categories. Moreover, a number of important ports are shifting from cargo to tourism by increasingly offering more marine transport services for passengers such as ferry boats and cruise ships

etc. For example, cruise ships have been described as 'floating cities', whose per capita pollution is actually worse than that of a city with the same population. This is largely due to weak pollution control laws, lax enforcement and the difficulty associated with detecting illegal discharges at sea.

An average sized, 3 000 passenger cruise ship in USA generates the following amounts of waste on a typical one-week voyage (Surfrider Foundation ⁽¹⁹⁾):

- 3 800 m³ of 'grey water'
- 800 m³ of sewage
- 100 m³ of oily bilge water
- almost 0.5 m³ of hazardous or toxic waste
- 50 tons of garbage and solid waste
- diesel exhaust emissions equivalent to several thousands of automobiles
- large quantities of ballast water, which can introduce invasive species (a typical release of ballast water amounts to 1 000 tons).

The European Maritime Safety Agency (EMSA) has recently undertaken an evaluation of how Member States have been implementing the EU Directive on 'Port Reception Facilities for Ship Generated Waste and Cargo Residues' (2000/59/EC). The overall objective of the directive is to reduce illegal discharges from the ships by improving

Box 20 Intensification of harbour services

Harbour restructuring is becoming increasingly oriented towards logistics and 'just in time' supply methods. Moreover, there has been an increase in the number of containers and of 'roll-on, roll-off' (ro-ro) services which allow transport multi-modality with roads and trains. Ports are being reconverted into container platforms to serve the growing volume of cargo. Transporting goods over long distances at sea adds relatively little to the overall costs, but harbour services are expensive. Transport is not the key cost. On the contrary, time within the harbour required to unload and reload cargo has become a the critical cost effective issue. Cargo ships used to wait outside harbours in long queues before docking. For historic reasons many harbours are located in the vicinity of the most valuable coastal ecosystems (e.g. estuaries, banks and reefs). As queuing involves anchoring and possible waste release, it damages the local environment. Often completely new, modern harbour areas are constructed next to older harbours, which in many cases have themselves been re-developed for the leisure industry.

Working practices in harbours have also changed from non-skilled, manual tasks (e.g. loading) to highly-skilled, technological tasks (e.g. operating computerised machines and crane systems). As a result, former porters and docker communities have suffered during this transformation within the industry. In order to attract clients, e.g. large transportation companies and their routes, harbours have needed a combination of good quality-price ratio of services, and efficient customs and control services. These conditions are also necessary for harbours if they wish to become a hub between sea and land traffic. To fulfil these new harbour functions land is needed, which can take a significant share of land from the coast. This often creates new artificial land development, which consequently armours the coast.

Source: ETC-TE expert judgment.

⁽¹⁹⁾ www.surfrider.org/a-z/cruise.asp —accessed 01.03.2006.

the availability and use of port reception facilities. The study should provide a clear picture of port reception facilities functioning within EU, ship-generated waste streams, and the effectiveness of waste handling and reception plans. This includes fee-systems ⁽²⁰⁾.

The Baltic Ports Waste Information System ⁽²¹⁾ helps ships to find information on waste reception possibilities and send in their requests. In addition, it allows ports to promote themselves. The system provides information on approximately 100 Baltic ports in Denmark, Poland, Lithuania, Latvia, Estonia and Russia. Information can be retrieved either for a specific port or a specific type of waste.

3.2 Resulting environmental quality

3.2.1 Status of ecosystems

Loss of biodiversity and habitat

Biodiversity loss is one of the predominant environmental problems affecting Europe's coasts, as biodiversity depend on the combined healthy state of land, freshwater and sea.

Coastal zones enjoy a great diversity of unique ecosystems and specific habitats as listed in Annex I of the EU habitats directive. There are nine main habitat complexes on coastal sites. These sites include forest, rocky habitats and caves, raised bogs, mires and fens, natural and semi natural grassland formations, sclerophyllous scrubs, temperate heath and scrub, freshwater habitats, coastal and continental sand dunes, and coastal and halophytic habitats. For example, there are 300 000 ha of coastal halophytic habitats in Europe. However, the current level of information available is not sufficient to identify trends.

The Corine land cover (CLC) database has been used to obtain an approximation of habitat trends between 1990 and 2000. However, it is a recognised shortcoming that CLC classes only partly fit with the main coastal habitats (forest, natural grassland, wetlands etc.).

Traditional forms of agriculture and livestock breeding have supported the management and survival of the main coastal habitats. Nowadays

these forms of agriculture are drastically declining and being replaced by intensive uses.

Mixed agriculture, pasture and natural grassland land cover have all decreased along European coasts, e.g. nearly 1 800 km² over the past decade. The main losses (e.g. 70 %) have occurred on the Atlantic rim in France, Portugal and Ireland. This trend is largely due to the conversion of pasture into arable crops, especially maize for cattle breeding.

It is estimated that approximately two thirds of all European wetlands which existed at the beginning of 20th century have now been lost (JRC ⁽²²⁾). In the Mediterranean, loss and/or degradation of coastal wetlands in this century amounts to 73 % of the marshes in Greece, 86 % of the most important wetlands in France and 60 % of wetlands in Spain (MedWet ⁽²³⁾). 390 square kilometres of wetlands, including marshes, and parts of coastal lagoons and estuary mudflats have suffered as a result of drainage used to create reclaim land for development and afforestation. Examples include peatlands in Ireland and parts of the 20 kilometre stretch of lagoons and salt-marshes of the Languedoc Roussillon coastline of southern France (EEA/UNEP, 2006).

Traditionally, many of these intertidal flats and wetlands have been regarded as having a low value. However, their environmental services such as hunting grounds, pollution filters, buffers against coastal erosion, storm surges and saltwater intrusion, absorbers of land based nutrients and pollutants, have been ignored by developers and regulators alike.

Ecosystems or habitats, such as estuaries, salt-marshes, lagoons, rocky shores, sea-grass meadows and sandy beaches are often very productive, but also very vulnerable to changes in the environmental conditions on the coasts. Coastal lagoons around Europe, especially in the Mediterranean, the Black Sea and the Baltic Sea are vulnerable to changes and sea level rise due to their low tidal range (EEA ⁽²⁴⁾). In fact, they are already experiencing drastic and irreversible changes to their ecosystems, as they react to both climatic trends and increasing human pressure (JRC, 2005).

Forest area is increasing slightly in European coastal zones. On the Mediterranean coast, this

⁽²⁰⁾ www.emsa.eu.int/end905d003d013.html — accessed 01.03.2006.

⁽²¹⁾ <http://62.236.121.189/portweb3/default.htm> — accessed 01.03.2006.

⁽²²⁾ http://esl.jrc.it/envind/meth_sht/ms_we042.htm — accessed 12.06.2006.

⁽²³⁾ www.iucn.org — accessed 06.06.2006.

⁽²⁴⁾ http://reports.eea.eu.int/technical_report_2005_1207_144937/en/EEA_Technical_report_7_2005.pdf — accessed 01.03.2006.

happens in combination with a withdrawal of traditional farming systems (i.e. methods for managing biomass production). In the past, different grazing methods helped avoid the accumulation of forest litter. Now forest litter poses a fire risk. However, forest fires and other hazards like storms also contribute to the rejuvenation of ecosystems.

The coastal sand dunes and associated ecosystem develop where there is an adequate supply of sand, wide beaches and onshore winds. Sand dune habitats have been suffering from degradation and physical destruction throughout Europe. Fixed dunes and dune heath are particularly threatened habitats and are regarded as priorities under the EU habitats directive.

Dune losses have been reported in many coastal areas. In Spain, their destruction is closely linked with urban development along the coastline. This has taken place in many Spanish regions (e.g. Andalusia, Murcia, Valencia, Balearic Islands or Catalonia). Camping sites are often installed on dune fields in Spain, Portugal or Germany. Furthermore, they have also suffered degradation because of over frequentation (e.g. in the Camargue, the United Kingdom and Nord-Pas de Calais). The ecological status of dune habitat in the United Kingdom, which comprises 54 500 ha in total, is currently classified as 'unfavourable with some improvements' at national level.

European sand dunes are experiencing an 'unfavourable decline' and constitute a threatened habitat throughout Europe (Cheshire ⁽²⁵⁾). It is, however, difficult to obtain information on surfaces covered by these formations at EU level. National information is sometimes available. However, local information updates are the most frequent.

Sub-tidal ecosystems, such as sea grasses, have also been deeply altered and have reduced their surface and/or density. The situation of *Posidonia oceanica* in the western Mediterranean is rather serious. Here, shoot density has been rapidly decreasing by up to 50 % over the past few decades (Coastal Guide ⁽²⁶⁾).

Eutrophication and algae bloom still evident

In general, nitrogen and phosphorus loads entering coastal water have been decreasing due to a significant improvement in wastewater

treatment plants. Nevertheless, a substantial part of the European population and settlements have insufficient urban waste water plant connection (e.g. 30 % in the Mediterranean Sea). Nutrient concentrations in Europe's seas have generally remained stable over recent years. Chlorophyll-a concentration monitored by satellite images show that the effected areas were the same in both 1998 and 2000. A longer series is needed to assess the quality of water. This issue remains to be addressed.

In the Baltic, the eutrophication problem, which is characterised by heavy algal blooms, was very pronounced during the summer of 2005. Very heavy algal blooms covered a large part of the Baltic, especially in the area west of the island of Gotland. As a result, the tourism industry suffered from a reduced number of visitors (Eionet consultation, Sweden).

The main source of eutrophication is agricultural run-off and urban direct loads released into the sea. The impact of eutrophication on coastal ecosystems is well assessed by the persistence of turbid conditions in transitional waters (IFREMER expert consultation, 2005). By relating water quality to ecosystem health, this indicator shows the impact of continuous water turbidity on the seabed communities, e.g. sea grass.

Coastal waters are the place where many sea species reproduce and live before coming back to the sea. Therefore, sea ecosystems depend greatly on the quality of water around the coastline.

Invasive species growing in numbers and effects

In a wide range of ecosystems, the accidental or voluntary introduction of non-native species by humans has altered biological community interactions. This has triggered dramatic and often unexpected changes in the ecosystem processes and caused large financial and cultural losses (MEA, 2005a).

Invasive species pose a greater threat to ecosystems on the coast, including marine and wetland ecosystems, than anything else. This is due to the fact that the species invasion via maritime transport and activities (e.g. ballast water and aquaculture) happens more easily, and is difficult to control. It is estimated that 12 billion tonnes of ballast water are carried around the world each year and that at any one time

⁽²⁵⁾ www.cheshire-biodiversity.org.uk/habitat-csanddune.htm — accessed 10.02.2005.

⁽²⁶⁾ www.coastalguide.org/eco/posidi.html, accessed 08.06.2005.

7 000 different species are carried in ships' ballasts. Changes in marine ecosystem structure caused by climate change, over-harvesting of resources or eutrophication have left the ecosystem vulnerable to invasion from alien species.

The most dramatic increase in the number of invasive species happened between the 1960s and the 1980s, particularly in the Mediterranean (Map 17). Cases are still reported and Europe's seas continue to become home to hundreds of non-native species, e.g. the red king crab in the Barents Sea. This species was deliberately introduced between 1960 and 1970, and their population increased six-fold between 1995 and 2002. Large quantities of a new species are a threat to some local benthic species and may compete with bottom-feeding fish (WWF (27)). For example, in the Baltic Sea, the crustacean invertebrate species (*Stenocuma graciloides*) was reported in 2004

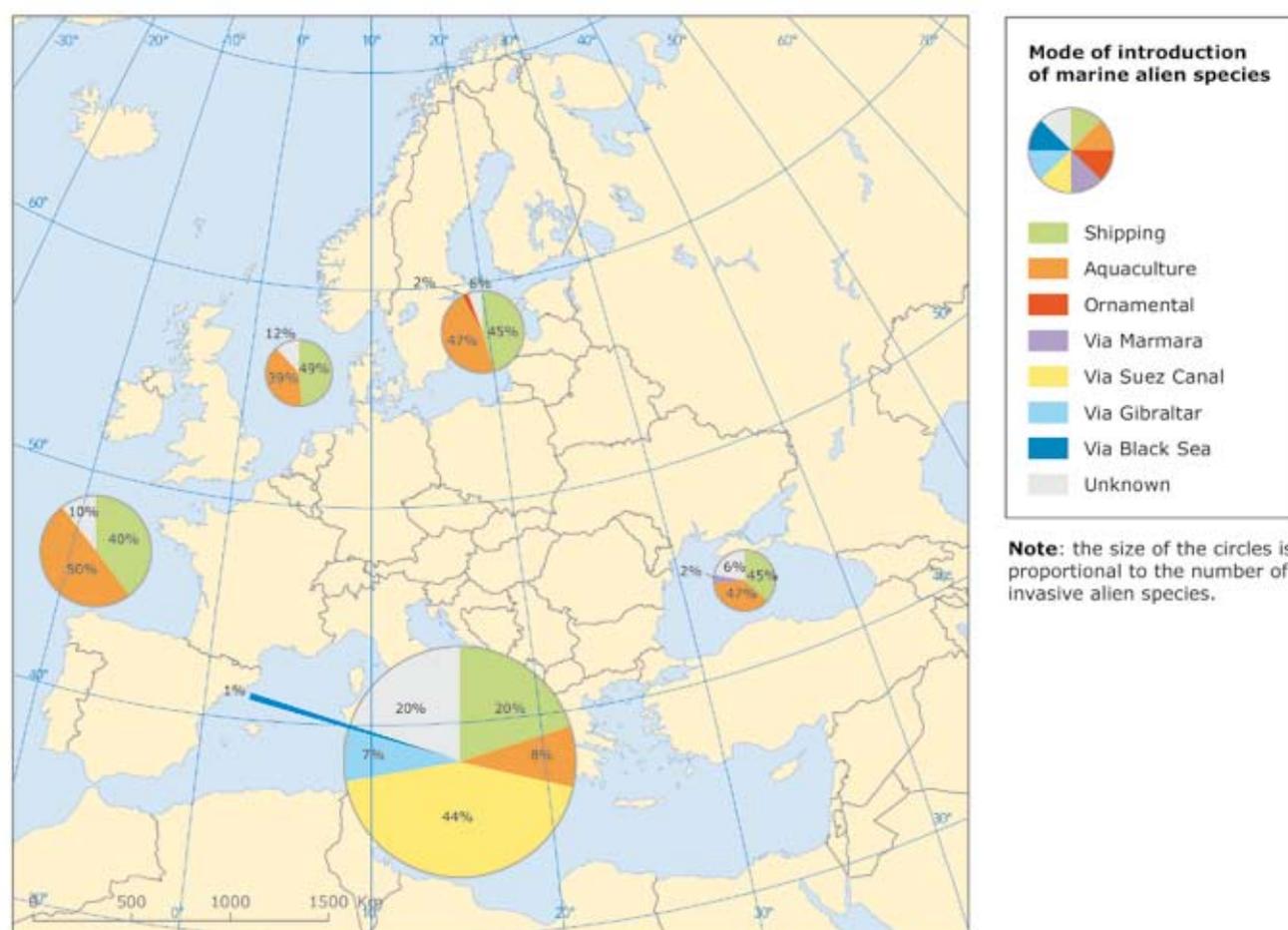
and the Round Goby (*Neogobius melanostomus*) in 2005. Both species originate from the Caspian Sea (Helcom (28)).

Bathing waters improving but hot spots remain

In the last few decades, both the coastal population and governments have become increasingly concerned about sewage discharges reaching coastal bathing waters in Europe, and the consequent risks this poses to public health. Moreover, bathing water quality is now one of the criteria tourists use to select their holiday destination.

Bathing water quality is a good indicator of the microbiological state of coastal waters, which is so important for human health. General trends show that bathing water is improving. However, hotspots

Map 17 Mode of introduction of marine alien species



Source: EEA, 2003.

(27) www.wwf.no/pdf/CBD_king_crab.pdf — accessed 01.03.2006.

(28) www.helcom.fi — accessed 16.05.2006.

are still present in areas with eutrophic conditions in the Baltic Sea, the Adriatic Sea, the northern Black Sea along the Ukraine coast and in the Azov Sea. At many bathing sites, problems arise after storms and heavy rains, as they bring the waste and polluted water from congested storm release networks to the sea.

3.2.2 Coastal systems at risk

Sediment balance and coastal erosion

Coastlines are becoming more and more vulnerable and large stretches of coasts are losing their resilience. This is due to the growth in artificial surfaces and preference of hard sea defences. Disequilibrium in both sediment balance and ecosystem health is expected to increase the level of risk to the coast, especially in densely populated coastal areas with little protection from natural sedimentation processes (e.g. the Netherlands, Belgium, Denmark, eastern United Kingdom, Atlantic coast of France and Portugal, and Mediterranean lagoons and deltas). Rising sea levels are expected to exacerbate this problem and some high coasts made of soft geological materials may be put at risk (e.g. cliffs from Pas de Calais and Normandy in France, the Dover cliffs in the United Kingdom and the Polish coast).

Significant stretches of the coast in Europe suffer from erosion (25 % of EU coast (Eurosion⁽²⁹⁾). To fight this, a number of sea defences has been constructed which cover 10 % of European coastlines. But these defences often lead to undesirable effects on sedimentary processes. They create new eroded areas and new problematic sedimentation areas, as the coastal defence installations act as a barrier to the natural littoral drift of the sediments. The increasing length of armoured waterfronts in Europe was intended to serve local interests, but did not take into account the wider sediment balances and impacts in neighbouring areas.

To fight the real cause of coastal erosion, it is necessary to recognise that there is an overall deficit of sediments on the coasts. This results from upstream dam construction on discharging rivers. Dams trap sediments as well as water, reducing the river bed and bank erosion (canalisation of rivers). Extraction of offshore sand and gravel deposits from the sea bottom often cause steeping of the submerged littoral zone. Dredging of ship channels, particularly in port areas, can also impact the sediment balance.

For example, some 20 million m³ of sediment is dredged annually in the port of Rotterdam alone. Even if most of the sediment is returned to the sea, significant parts are relocated to storage areas in accordance with chemical criteria regulation (Vellinga and Eisma, 2005).

The changes in sediment balance have resulted in an annual loss to Europe's coastal systems of an estimated 100 million tonnes of material (Eurosion⁽³⁰⁾). On a global scale, some 25 % of the current sediment load from land to the coastal zones is trapped in river reservoirs. Assuming that the global natural sediment discharge is 18–20 billion tons per year, the combined impact of all large dams will be of an order of 4–5 billion tons per year (Vörösmarty *et al.*, 2003). It has been estimated that the amount of solid discharge retention by dams in the Ebro river is about 96 % (Sanchez-Arcilla and Jimenez, 1997).

The sustainability of sediment balance is an important challenge for Europe's coastal zones. However, it should be viewed in the wider context of sustainable river management, sea level rise and increasing coastal erosion impacts on the shoreline and intertidal areas. Improving coastal resilience by restoring the sediment balance will require identifying areas where essential sediment processes occur, and establishing 'strategic sediment reservoirs' from where sediment can be taken without endangering the natural balance.

In terms of a management strategy, the main objective should be to shift from coastal defence and beach management to sediment management. Modern methods of 'soft' coastal engineering that reinforce natural buffers against the rising tides, such as dunes and salt marshes and the protection of key sources of sediment, will help maintain coastal sediment balance and the stability of coastal systems (EEA, 2005).

Natural and technological risks

In Europe, earthquakes have killed far more people than any other extreme event, and have caused extensive damage. Europe's major earthquake-prone areas are in the Mediterranean and Black Sea basins along the active fault lines between the Eurasian and African plates. It is not unreasonable to be reminded of the 60–100 thousand victims who lost their lives in the Great Earthquake and Tsunami of Lisbon 1 November 1755. This was caused by considerable ocean floor subsidence

⁽²⁹⁾ www.eurosion.org, accessed 17.03.2005.

⁽³⁰⁾ www.eurosion.org, accessed 17.03.2005.

Box 21 Warning – jellyfish invasion

The recent invasion of jellyfish in bathing waters occurred along the Mediterranean coast in the second week of August 2005. It affected 127 people along the Catalan coast alone (compared with six people the year before, according to the Red Cross), and led to the red flag being raised at numerous beaches when the sea was otherwise calm and bathing conditions perfect. The sea was converted into a 'huge field of stinging nettles'. Experts have interpreted this invasion as a symptom of the sea losing its ecosystem equilibrium (Pauly, 2003).

This explanation is based on changes in three main parameters in the sea:

- Jellyfish like warm waters. The sea could have become warmer because of climate change, which has contributed to an augmentation of the sea temperature.
- Jellyfish feed on plankton, which reproduce and thrive in warm waters under eutrophication conditions. Waste water offers plenty of nitrates and phosphates. When they are added to loads arriving from agriculture, an excess of nutrients are created which provoke eutrophication. These conditions are perfect for jellyfish and allow them to flourish.
- Predators of jellyfish, such as marine turtles and big fish are disappearing. Each year 25 000 marine turtles are accidentally caught.

Increases in jellyfish numbers are expected worldwide. However, there are instances of a decrease in the population due to heavily impacted coastal areas. Some jellyfish species will undoubtedly become extinct as part of the global loss of biodiversity (Mills, 2001).

Source: ETC-TE, based on Pauly *et al.*, 2003, and Mills, 2001.

around 200 km from the coast at Azores-Gibraltar fracture zone in the Atlantic Ocean (Lisbon earthquake ⁽³¹⁾). Such events, even if only happening relatively infrequently over long periods of time confirm that coastal natural risks do exist in Europe and can hit at any time. About 70 tsunamis have affected the Italian coast over the last 900 years. The largest tsunami recorded was in Messina 1908 which cost approximately 10 thousand lives (Ortolani ⁽³²⁾). Unsustainable practices on the coast, such as the destruction of sheltering ecosystems, excessive sand mining on the coastal sea bottom or massive residential build up of the waterfronts, only increases the vulnerability of the coast to the impact of such events. Similar vulnerability was demonstrated by the south-east Asian tsunami in December 2004.

Europe has a high concentration of nuclear plants. These plants are mostly located either along rivers or the coast, as they need a large quantity of water for the cooling process. Discharges of warm cooling water can produce alterations of coastal aquatic life, reducing fish stocks and disrupting the balanced ecosystems. In addition, the heated water is discharged with such a force that surrounding sea beds are often scoured to bare rock, leaving a virtual marine desert on the ocean floor.

Technological hazards and accidents related to nuclear power plants are well known, e.g. Chernobyl in 1986. Moreover, a number of nuclear plants are at risk from coastal erosion, for example in the United Kingdom where hard and soft sea defences including new wetlands are constructed in front of them to avoid a direct attack from the sea. Nuclear waste has been discarded into deep sea over a long period of time, and uncertainties remain about the durability and lifetime of these sealed boxes. From a global perspective, an estimated 313 000 containers of low-intermediate radioactive waste has been dumped in the Atlantic and Pacific Oceans since 1970. This would pose a significant threat to deep-sea ecosystems should the containers leak (MEA, 2005a).

Favourable trade and logistics conditions at marine port areas also attract sectors of the chemical industry dealing with dangerous substances. Resulting concentrations of chemical plants in coastal zones pose a permanent potential threat to the coastal population and ecosystems. Major accidents involving installations along coastlines, which may cause immediate damage to marine and terrestrial habitats, is subject to regulation by SEVESO II Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (EEA, 2004).

⁽³¹⁾ www.lisbon-and-portugal.com/travel/1755-lisbon-earthquake.html — accessed 31.01.2006

⁽³²⁾ <http://atlas-conferences.com/cgi-bin/abstract/caqy-42> — accessed 31.01.2006.

Petro-chemical plants and storage facilities in particular pose a permanent accident hazard because of the large amount of oil and petroleum products concentrated at one single location. Potential threats may also rise from pipelines.

3.2.3 Protection of coastlines

The UN Millennium Ecosystem Assessment has concluded that two-thirds of the world's

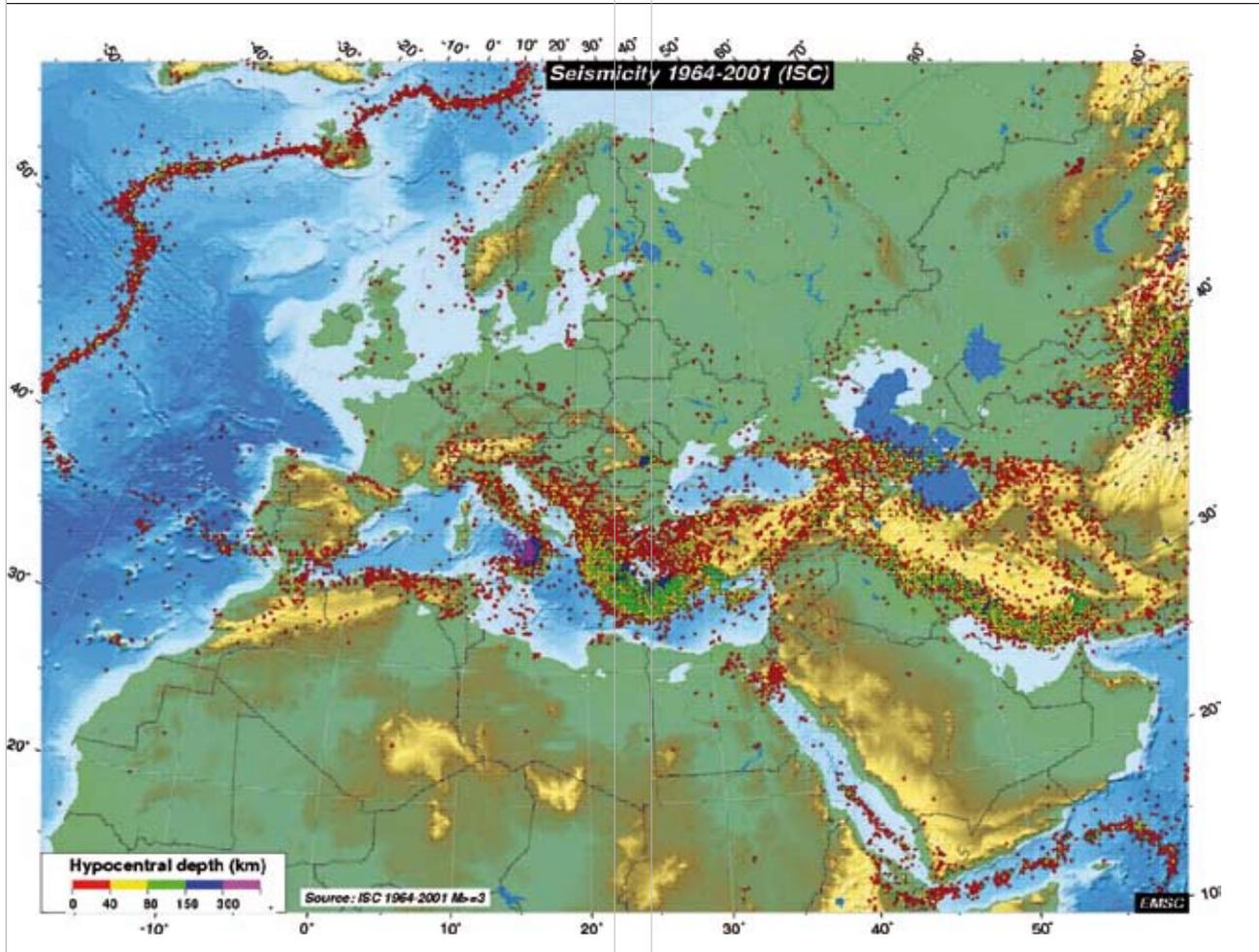
ecosystems, ranging from wetlands and coastal areas to forest and soils, are either degraded or managed unsustainably. The net value or benefit of many ecosystems is higher where they are intact and not damaged or converted for other uses. For example, an intact wetland in northern countries is worth nearly USD 6 000 per ha. However, this value falls to just over USD 2 000 per ha if the wetland is drained and made ready for intensive agriculture.

Box 22 Earthquake threat in the Mediterranean region

The most dramatic events in recent decades include the 1980 earthquake in southern Italy which killed 4 500 people and left more than a quarter of a million homeless. But the most powerful and destructive of these was the Izmit earthquake (Turkey) in August 1999 which killed an estimated 17 000 people and caused more than EUR 15 billion in losses. The following month a seismic tremor struck the northern neighbourhoods of Athens, killing around 140 people and leaving more than 60 000 homeless. The latest major earthquakes took place in Turkey in April 2003 and in Algeria in May 2003. The effects of the latter event were felt in the Balearic Islands in the form of a small tsunamis that sank several recreational boats.

Source: EEA, 2004.

Map 18 Earthquakes in Europe and adjoining areas (1964–2001)



Source: European-Mediterranean Seismological Centre, 2001.

As stated by the Executive Director of UNEP, Dr. Klaus Toepfer, 'We need imaginative financial mechanisms and incentives to give these resources real value and to encourage reinvestment in the natural capital we have already overused' (Millennium Assessment Report ⁽³³⁾).

The European report for the Ramsar Convention COP9 meeting (Uganda, 2005) prioritised the need to integrate wetland policies fully into other strategic and planning processes, including integrated coastal zone management between 2006 and 2008. The report pointed out that for many European countries this goal would remain a major challenge (Ramsar ⁽³⁴⁾).

Even though protection of natural areas in Europe has improved, i.e. with more surfaces being placed under designation, the tools for assessing the status of species and habitats in Natura2000 sites are still under development. They should provide the opportunity to judge whether the network of Natura2000 sites is sufficient for the preservation of these habitats (Eionet consultation, Finland).

Whether this will be achieved depends not only on the area but also on the quality of the sites. The way in which protection management happens also matters. Protection could take place by designing corridors based on connectivity or connectedness or restoring habitats for different species. As a result, assessing whether Natura2000 implementation is sufficient or not will be a very complex issue. A new concept of protection for the entire territory (and not only specific sites) should therefore be implemented.

Coastal zones, both at sea and on land, have been identified as the place with the highest level of biodiversity within the entire EU territory (ELOISE ⁽³⁵⁾). Intensification of built up areas occurs especially in the coastal strip, i.e. the first kilometre inland from the shoreline. The high degree of occupation of this land either directly or indirectly affects all coastal ecosystems. Habitat protection has only recently been taken into account in planning instruments. Moreover, the development and intensive occupation of this area becomes a private socio-economic privilege when the seafront areas come on to the property market. This creates restricted access to the coast due to private property, and undermines the common value of shoreline ecosystems. National coastal law (where applicable) de-limits this availability for development in most

EU countries, but needs good implementation and enforcement.

Initiatives have been taken by some countries to draw up specific protection figures for the coast. This is the situation in the Baltic Sea region where protection is carried out through planning instruments. Currently there are 418 Natura2000 areas (i.e. more than 7 000 km²) along the Swedish coast. These areas encompass both land as well as marine areas. 270 of these 418 countries include marine habitats; the total area of which is over 3 200 km². The recent addition was the Kungsbackafjordens marine nature reserve, which was inaugurated in September 2005 (Eionet consultation, Sweden).

In France, the Conservatoire du Littoral et des Rivages Lacustres has carried out the equivalent service since 1975. It purchases land and takes it off the real estate market. Today, this land represents around 70 000 ha of important habitats and coastal landscapes. New areas are bought every year. Previously, this land was managed by local communities and associations. The ONF — Organisation Nationale des Forêts — also participates in the management of these areas. Moreover, the ONF has the responsibility of managing national forests. A significant share of these sites is located by the coast.

The Conservatoire sites are open to the public and attract a great many visitors. For example, one million visitors per year visit one Mediterranean site alone. The problem of too many visitors needs to be addressed and balanced with conservation and awareness building among the public. Spain is presently preparing to enforce a law in 2006 based on a system similar to the French Conservatoire.

It is expected that sea level rise and the associated inundation, combined with a high rate of erosion can put settlements near shorelines in danger. This is especially the case in lowland areas. In the light of this risk, some initiatives for de-construction or urban set back have taken place along different coasts in Europe. Flooding episodes and erosion risk, for example in the United Kingdom, have also triggered initiatives. Other de-construction initiatives have been carried out in response to market drivers, for instance to modernise and restructure hotel parks that do not meet new standards. This has created a better environment

⁽³³⁾ www.millenniumassessment.org/en/products.aspx — accessed 12.04.2005.

⁽³⁴⁾ http://www.ramsar.org/cop9_doc11_e.doc — accessed 14.09.2005.

⁽³⁵⁾ www.eloisegroup.org/themes/climatechange/casintro.htm — accessed 27.02.2006.

in places (e.g. Calvia Agenda 21, Mallorca). Finally, stringent legislation has also led to de-construction initiatives.

Although still relatively rare, these initiatives demonstrate how social perception is slowly changing. Often referred to as a 'managed retreat' (EEA, 2005) or 'managed realignment' (e.g. UK case study of River Humber estuary provided by ELOISE ⁽³⁶⁾), these actions are aimed at promoting greater respect for natural processes within coastal management. Current coastal practices are producing widespread coastal squeeze of intertidal habitats, such as salt-marshes and other coastal wetlands. These practices are reclaiming new coastal areas for urban development or agriculture and setting up hard coastal defences, which fix the coastline position and restrict natural coastal dynamics.

By recognising the short term perspective of coastal squeeze, managed realignment can provide natural flood defences. Working with natural processes rather than against them will provide additional benefits through the creation of inter-tidal habitats. These benefits include recreation, carbon storage, improved water quality and educational values. However, land which was previously defended will be lost, and therefore careful cost-benefit analysis is needed (Coombes *et al.* ⁽³⁷⁾).

Through the maintenance and enhancement of natural buffer zones, coastal squeeze can be reduced and even avoided. More variability in coastal zone management also affords a better ability to cope with climate change impacts within coastal zones (Rochelle-Newall *et al.*, 2005). By returning more space to nature and allowing natural landscapes to be restored, a higher value is being given to the quality of the coast.

For an ecosystem approach, management practices in the coastal zone should be linked to river basin management. They should take into account the entire river-coast ecosystem continuum of discharging rivers, their catchments (including the flood plain) as well as the marine area of the coastal zone. This will provide both a better understanding of the entire coastal system and facilitate better design of management strategies. In future, it will be necessary to connect such integrated management with maintenance and enhancement of natural sinks and buffers in coastal zones. Moreover, an integrated management strategy should be monitored for both its effectiveness and limitations in ensuring human safety, economic development and ecological integrity (Rochelle-Newall *et al.*, 2005).

Coasts will also benefit from an enlarged network of Marine Protected Areas (MPA). At the World Summit on Sustainable Development (WSSD) in Johannesburg 2002, governments agreed to create networks of marine protected areas before 2012. The system of MPAs has been recommended by European Regional Sea Conventions (e.g. OSPAR and Helcom) and is consequently being implemented by participating member countries. The main objective of creating MPAs is to halt and reverse the decline of marine habitats and species by reducing the impact of human activities on the marine environment. It is also intended to provide a safe haven for depleted and vulnerable fish stocks to breed in and recover. MPAs should then be able to foster the application of an ecosystem-based approach to the management of human activities at sea (WWF, 2003). Networks of MPAs are proposed in the form of designated sea areas, where marine uses (fishing, shipping, off-shore wind energy, extraction of oil, gas or aggregates etc.) are carefully monitored or restricted. The establishment of MPAs can also be seen as a step forward in the spatial planning of sea areas.

⁽³⁶⁾ www.eloisegroup.org/themes/climatechange/caseintro.htm — accessed 27.02.2006.

⁽³⁷⁾ http://www.eloisegroup.org/themes/climatechange/doc/case_study.doc — accessed 27.02.2006.

4 Current trends in policy responses

Promoting public awareness about coasts has been a long standing and complex issue. Early policies affecting the coastal zone were predominantly issue oriented (e.g. water quality) and reactive in nature. Furthermore, the governance of coastal and marine areas has remained fragmented between countries and thematic areas (e.g. sectors) at both national and European level.

Policy documents for Integrated Coastal Zone Management (ICZM) are the first to recognise three critical areas, namely: the importance of land/sea interaction; the human dimension in coastal processes; and the need to integrate different sectors and stakeholders in order to avoid the type of conflict which leads to unsustainable development.

4.1 Development of policy

Since the 1970s the EU has been dealing with coastal zones through international conventions covering its regional seas. More recently, the EU has begun to specifically address problems related to the state of the coasts⁽³⁸⁾ and the coast as an regional entity. This has resulted in two policy documents:

- the Commission communication on Integrated Coastal Zone Management: the Strategy for Europe (ICZM Strategy, COM(2000)547 final)
- the European Parliament and the Council recommendation concerning the implementation of Integrated Coastal Zone Management in Europe (EU ICZM Recommendation, 2002/413/EC).

Coastal zones are also addressed in other legislation, such as the environmental impact assessment directive (2001), the water framework directive (2000), the quality of bathing water directive (1976, agreed for amendment in 2005) and the directive on quality required of shellfish waters (1979). In addition, coastal zones are also highlighted by the European spatial development perspective (1999). Also, the EC Treaty (1999) Art. 130a (promotion of economic and social cohesion) mentions islands

as areas requiring special attention. Most recently, the Commission's communication on the European Marine Strategy (COM(2005)504), the related Marine Strategy Directive proposal (COM(2005)505) and the future Maritime Policy (Green Paper⁽³⁹⁾) are also very relevant to coastal zones.

Nevertheless, in practice, identifying and implementing dedicated EU coastal policies has been slow. A first communication on the integrated management of the coast in 1973 (Committee of Ministers Resolution (73) 29 on the protection of coastal areas) has needed more than 20 years to be tested in 10 pilot sites through the EU's ICZM demonstration programme (1996–1999). The EU recommendation on ICZM (2002) was completed almost 30 years later. This key policy document is an important breakthrough for the ICZM realisation. However, being a recommendation it completely relies on voluntary measures from individual Member States. This also offers some opportunities for integrating the existing legislation — directives, programmes and frameworks — that play a role in managing the coast.

At the same time, the approach laid down by the ICZM strategy and the EU's ICZM Recommendation underlines the need for a flexible, problem-oriented response. This is due to the diverse physical, economic, cultural and institutional characteristics of Member States. The underpinning ethos is one of governance by partnership with civil society. Here, the EU should provide leadership and guidance to support implementation at other levels, as emphasised by a subsidiarity and proportionality clause in the EU's ICZM Recommendation. It is also important that, where possible and relevant, the European approach to the ICZM builds on existing instruments and programmes. Often, these instruments will not necessarily have been designed with coastal zones in mind (Ledoux *et al.*, 2005).

At national level, the situation is very similar, for example, in France. 30 years had passed since the last alert message from the CNADT littoral

⁽³⁸⁾ <http://europa.eu.int/comm/environment/iczm> — accessed 09.06.2005.

⁽³⁹⁾ http://ec.europa.eu/maritimeaffairs/policy_en.html — accessed 13.06.2006.

Commission (Conseil National de l'Aménagement et du Développement du Territoire). This coincided with the parliamentary decision to implement the French ICZM strategy.

National policies have played an important role in helping coastal zones to withstand or delay pressures, e.g Danish planning laws prohibiting uncontrolled urban sprawl and France's Conservatoire du Littoral's remit to withdraw land from the real estate market and support natural landscapes and biodiversity values.

Other examples such as the Spanish 'Ley de Costas' from 1988 was intended as an integrated approach to coastal planning. However, it failed to identify a good line of implementation, and thus resulted

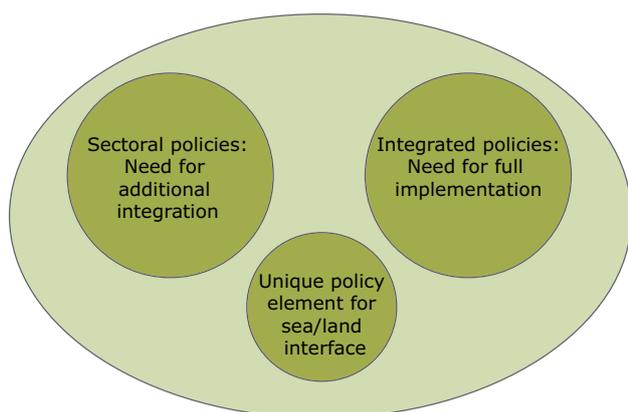
in limited applicability. Nevertheless, it should be highlighted that this kind of legislative initiative presents a good opportunity for integrated measures as the coastal zone is viewed as a whole and managed in a similar way to public land. Hence, direct intervention of public administration is possible. During 2005 the Spanish government, the 10 coastal autonomous communities and two coastal autonomous cities began implementing the future coastal management plan for the coast of Spain in accordance with the ICZM strategy.

4.2 The main elements of current European policy framework for coasts

Coastal zones cannot be managed by a single body of legislation. Due to the complexity of coastal zones and their environment, an appropriate blend of different policy instruments is needed. This should be fused with an holistic vision targeting the sustainable development of coasts.

To be policy-relevant, an assessment of the state of coasts in Europe needs to address the driving forces behind coastal change. Some aggregation of European key policy areas and regulatory frameworks that are relevant to coastal zones will allow more focused policy analysis (see Figure 16). Taking an environmental perspective, the main economic sectors are identified as environmental pressures that need additional integration. At the same time, they also represent constituents of integrated policies where they play a key role in

Figure 16 Approach for policy analysis of coastal areas



Box 23 Swedish national strategy for the marine environment

In 2005, the Swedish government presented a national strategy for the marine environment. In a communication the government pointed out that the short-term and long-term work on the marine environmental should be linked. The aim is for more coordinated planning and management of Swedish sea areas, and the government wants to further develop already existing instruments. In order to make more holistic planning and management work possible a more knowledge-based foundation for planning the coastal and marine environment has been requested. The Swedish EPA is expected to be awarded the task of providing this foundation and will work with other concerned sector agencies and organisations.

Furthermore, the government intends to improve coordination and integration by establishing a special marine coordination group. This group will comprise the executive directors of the responsible marine sector agencies. In addition, a Marine Council will be established which will have an advisory role to the government.

The Swedish government has also presented a parliament bill on the Swedish Environmental Quality Objectives. The goal of the Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos Objective is to preserve biological diversity and ensure that the North Sea and the Baltic Sea have sustainable productive capacity.

Source: Eionet consultation, Sweden.

achieving sustainable development and quality of life for coastal population.

Specific ICZM policy elements act as a catalyst and facilitate links between sectoral and/or broader integrated policies. By focusing specifically on the coastal zone as a spatial continuum, legislative acts relevant to ICZM provide a coherent policy framework for the coast. This framework should assure that legislation, subsidies, investments, spatial plans and resource management strategies do not have adverse impacts or pose risks to life and property. Furthermore, they should not make inefficient use of capital or lead to foreclosure of resource development options. The principle of ICZM has to move the process of coastal integration further. Currently, the overall effective implementation of the EU's ICZM Recommendation is not happening. Therefore, something should be done. Action should include good coordination between existing legislation (such as the water framework directive), the thematic strategy for marine environment and the future maritime policy.

4.2.1 Policies of key economic sectors

The integration of key sectoral policies is essential for coastal zones because of the impact of different economic activities on the limited space within coastal zones. The carrying capacity of fragile coastal systems are often more limited, if compared to inland or off-shore systems.

Sectors, such as fisheries and transport, have often been managed independently of one another, and until recently have not taken coastal zones into account. As a result, the economic development taking place within coastal areas has paid scant attention to the environment. However, the effects of different sectors on the state of the coast can be significant and different from those inland.

Currently, there is no EU policy for **Tourism**. This is due to Article 3 of the Maastricht Treaty, which gives the European Community limited scope to take forward non-legislative measures on tourism. However, the Council of the EU has outlined a vision for European tourism, which includes aspects of sustainability, in its Resolution of 21 May 2002 (2002/C 135/01).

The European Commission has adopted the communication, 'Basic orientations for the sustainability of European tourism' (COM(2003) 716 final). It outlines the challenges

and objectives of sustainable tourism. The Tourism Unit in the European Commission (DG Enterprise) is currently considering whether to develop a programme for sustainable tourism in the EU. This would correspond with international developments (e.g. Convention on Biological Diversity Guidelines on Biodiversity and Tourism Development (2004) and UNEP principles for Sustainable Tourism). Activities linked to the tourism industry result in several environmental pressures, many of which are very relevant to coasts. These include the use of land and water resources, aesthetic aspects of coasts, safety of seafood and bathing water, the physical disturbance of ecosystems and the development of residential areas.

Agriculture has an important role for the coasts, even though it is obviously not a maritime activity. The reform of the Common Agriculture Policy is certainly beneficial for coastal zones because reorientation from production to broader rural development will reduce pressures on fragile coastal ecosystems. This will be enhanced by a requirement for the cross-compliance of agricultural activities with other policies, in particular environment. At the same time, agricultural production around densely populated areas is becoming more and more specialised and intensive. This is driven by tourism and the increasing popularity of coastal areas. Displaced by urban expansion, intensive agriculture production may suppress traditional agricultural schemes, including high nature value farmlands.

Fishing is only partly considered as a coastal zone activity, since the majority of catches are made in more remote waters. Nevertheless, fish landing and processing as well as the share of fishing taking place in the coastal zone provide major sources of employment and therefore affect the life of coastal communities. The reform of the Common Fisheries Policy has been driven by the need to respond to unsustainable fishing patterns, which often lead to reduced fishing capacity. Similarly, the expansion of aquaculture needs more coordinated management. This is also the aim of integrated resource management plans for fisheries and the creation of regional advisory councils.

Transport: The EU common transport policy is the basis for the development of trans-European networks, which also includes short-sea shipping and new concepts such as Motorways of the Sea (European Commission⁽⁴⁰⁾). Coastal ship traffic in Europe has been constantly increasing and

⁽⁴⁰⁾ http://europa.eu.int/comm/transport/intermodality/motorways_sea/index_en.htm — accessed 03.02.2006.

needs well-defined responses. The future maritime policy will address the sustainability of marine transport and its impact on European coasts. This should be linked with the construction of transport infrastructures along the coastline and the increasing road building. This would then require integrated spatial planning.

Industrial installations exist on both sides of the coastline and are growing. They are attracted by logistic opportunities (e.g. oil refineries, port facilities) or coastal resources (e.g. wind farms, oil rigs). Most of these facilities are large enough to be covered by the integrated pollution prevention and control directive (IPPC). Therefore, a lot can be achieved by implementing spatial planning on the coastal strip and territorial water. Effective clustering of these industries and careful assessment of their environmental impact have an important role in reducing the negative impact on coastal ecosystems and the sustainability of coastal zones in general.

4.2.2 Cross-cutting and integrated policies

In recent years, the EU has been continuously developing the frameworks and legislative base for facilitating an integrated, cross-cutting approach in

policy. Such integration objectives are yet to make their mark on coastal zone management, especially in the context of the territorial cohesion objectives of the EU.

There are several integrated and horizontal policies which are not directly aimed at coastal zones but are nevertheless very relevant to the sustainable development of coasts. These include:

- policy frameworks: European spatial development perspective, Sustainable development strategy, 6th EU environment action programme and most relevant thematic strategies (marine environment, soil protection, urban environment);
- water framework directive (supported by urban waste water treatment, nitrate, bathing water and shellfish waters quality directives);
- birds and habitat directives (Natura2000);
- environmental impact assessment directive (1997);
- strategic environmental assessment directive (2001);
- structural funds and the cohesion fund.

The birds and habitat directives provide the basis for protection of coastal ecosystems

Box 24 Revision of the bathing water quality directive

In October 2005, the Council and the European Parliament agreed on a revision of the directive on bathing water quality. The old bathing water directive from 1976 will be repealed and replaced, so as to reflect development made in scientific knowledge and managerial experience since 1976. In particular, changes concern better public information and the introduction of new standards (category 'sufficient'). There are also plans to identify sources, reduce the risk of pollution and make provisions for implementation and the further review of the directive in 2020. The new directive will complement the water framework directive as well as the directives on urban wastewater treatment and on nitrates pollution from agricultural sources. The directive is scheduled to be implemented within two years of it coming into force (early 2008).

Source: European Commission, Revision of the bathing water directive (See www.europa.eu.int/water/water-bathing/index_en.html — accessed 08.03.2005).

Box 25 Action plans for European regional seas

The European marine strategy foresees a separate action plan for each European sea with a view to implementing the EU marine policy. In summer 2005, the Helcom Member States and the EU agreed to develop a strategic Baltic Sea action plan by 2007. This should ensure that all possible measures are taken to reduce pollution in the Baltic Sea and ensure that damage done to the marine environment is repaired. The plan is based on ecological objectives, which reflect a common vision of a healthy Baltic Sea. The ecological objectives and their associated indicators will be used to evaluate the efficiency of existing environmental measures and to provide guidance for the development of future management measures for the region.

Source: Helcom, 2005.

(Natura2000) and the water framework directive sees coastal waters as part of river basin districts. It therefore provides a legal basis for treating coastal zone as a single system. A strategic environmental assessment directive provides the basis for integration of environmental concerns in sector policies. The environmental impact assessment directive demands assessments for any development project affecting specified natural systems, including coastal zones.

In particular, the habitat and birds directives and WFD have very important and significant implications for other sectoral policies.

The Commission's communication on the European Marine Strategy (COM(2005)504) and the related Marine Strategy Directive proposal (COM(2005)505) follows the overall objective of protecting and restoring Europe's oceans and seas, and ensuring that human activities are carried out in a sustainable manner. To achieve this objective, the strategy must draw up principles, such as:

- a dual EU/regional approach to ensure that planning and execution of measures is carried out at regional level;
- an ecosystem-based approach that promotes the integrated management of sea resources and coastal systems;
- knowledge-based policy making;
- co-operation between all relevant stakeholders and regional seas conventions.

The strategy sets up a framework for enhanced co-operation and proposes a legal instrument, e.g. the marine strategy directive. This provides the objective of achieving good environmental conditions in Europe's marine environment by 2021, which is the time of the first review of the river basin management plans under the EU water framework directive. The MSD proposal also delineates European marine regions and sub-regions by promoting an ecosystem approach, and facilitating spatial monitoring and assessment programmes.

The marine strategy states that implementation will only provide a supportive framework for national strategies foreseen by the EU's ICZM Recommendation and for spatial planning in general.

The role of the Strategic Environmental Assessment Directive (2001/42/EC) is essential for addressing conflicts in the long-term development of coastal zones, and for backing the ICZM. The full potential

of the SEA directive in addressing the cumulative impacts of individual economic sectors is an important factor in coastal zone management. Its implementation by Member States will broaden the scope of all development plans and programmes. The SEA directive provides good grounds for integrated spatial planning and risk management, with a view to increasing the sustainability of coastal zones.

Integrated coastal management should greatly help improve coordination among policies, sectors and across scales. It would promote integration and coherence between all relevant policies, both horizontal and vertical. For instance, in Sweden the Planning and Building Act is the instrument that can bring the different sector agencies together. This act is currently under review, and ICZM issues are being considered (Eionet consultation, Sweden).

There has been relevant progress in the last five years in integrating environmental issues into spatial planning, and in developing a forum and Agenda 21 to initiate public debate and participation. The indicator which measures progress on ICZM, developed by the Working Group on Indicators and Data (WG-ID) for the EU ICZM Expert Group, has been tested by different countries and regions during 2005. 'Guidance notes for completing the progress indicator' were produced by the WG-ID. France, Poland, Belgium, Malta, the southern United Kingdom, a number of regions in Catalonia, Spain, Emilia Romagna in Italy and the Forum of the Adriatic and Ionian Cities & Towns have organised meetings with different levels of administration (e.g. national, regional, local) and different sectoral stakeholders. These meetings were intended to implement the ICZM progress indicator and evaluate the current state of ICZM. Furthermore, it is expected that a number of countries will work on assessing their ICZM status during 2006 (e.g. northern United Kingdom, Germany, Portugal, Ireland, and others). Testing is carried out through EU projects such as COREPOINT Interreg IIIB. This testing shows that concrete steps are being taken towards achieving sustainable development. To complement the progress indicator in ICZM, WG-ID has also produced a suite of sustainability indicators to measure the success of coastal management initiatives. The Interreg IIIC project DEDUCE has recently commenced. This will calculate the set of 27 indicators, developed by the WG-ID, in order to measure the sustainability of coastal development at local, regional, national and European levels by applying a common methodology.

4.2.3 Policy elements addressing the sea/land interface

One of the difficulties of coastal management so far has been the absence of policy elements which comprehensively tackle the area between the sea and land boundary. ICZM aims to preserve coastal resources, their ecological functioning and ultimately their values by applying adequate land use planning within a social, institutional and economic context (Skourtos *et al.*, 2005).

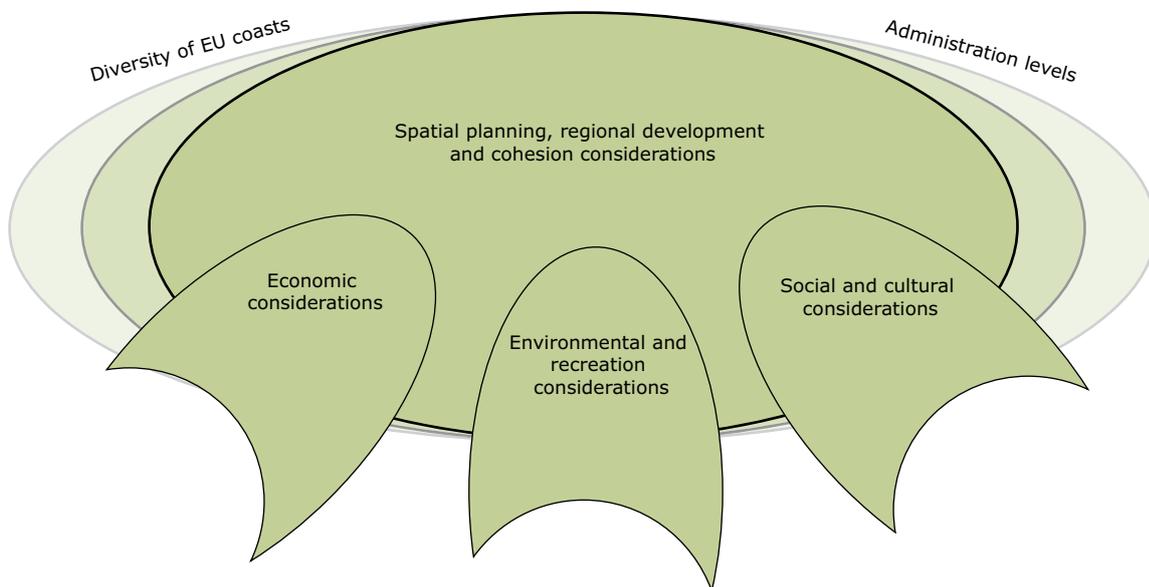
Within this context, the EU's ICZM Recommendation provides an earlier framework, which is so far unique. The Recommendation clearly addresses the coasts from the standpoint of sustainable development, and encompasses economic, environmental and social aspects (Figure 17). The EU's ICZM Recommendation provides an opportunity to enhance the sea/land interface within a sustainable development perspective, in a similar way to the forthcoming EU maritime policy.

As discussed earlier, the thematic strategy for the protection of the marine environment deals with the land/sea interface by prioritising the good environmental quality of marine regions. Using an ecosystem approach, this objective focuses on tackling land-based pressures to the marine environment, such as water, nutrient and sediment discharges from river catchments, coastal urban centres and ports, natural debris, and the air-borne deposition of nitrogen, heavy metals and some chemicals.

The Green Paper for a European maritime policy (2006) targets vitalisation of the whole maritime sector of Europe. By acknowledging that 80 % of ocean pollution results from land-based human activities, the consultation document of the forthcoming maritime policy show a clear link between the marine and terrestrial environment, including the sea/land interface, and therefore coastal zones. However, maritime policy is aimed at embracing the whole complexity of disconnected areas. This includes maritime transport, fishing, aquaculture, oil and gas exploration, use of wind and tidal power, shipbuilding, tourism and marine research. These activities increasingly compete for land and space and are visible on the coast. Therefore, the need for integrated coastal management and development in Europe's regional policy is recognised. The EU's ICZM Recommendation could support maritime policy development.

As stated by Commissioner J. Borg (speech 17.02.2006) in the drafting of the Green Paper, 'We have been confronted with the challenge of finding the balance between economic growth and the exploitation of our seas on one hand, and preservation of the ocean environment on the other.' He also admitted that without a healthy and sustainable marine environment any potential economic benefits from oceans will be short lived. By including in the Green Paper a discussion on maximising welfare in coastal regions, maritime policy aims for a comprehensive approach to ICZM and to managing the sea/land interface, coastal

Figure 17 ICZM: the sea/land interface in a sustainable development perspective



safety and disaster preparedness (including climate change implications), sustainable development of coast tourism and a holistic perspective on littoral as a place to live. These elements are only confirmed by other sections that discuss 'healthy' oceans (e.g. the thematic strategy for the marine environment) and spatial planning for the growing maritime economy; both of which rely on the ecosystem-based approach.

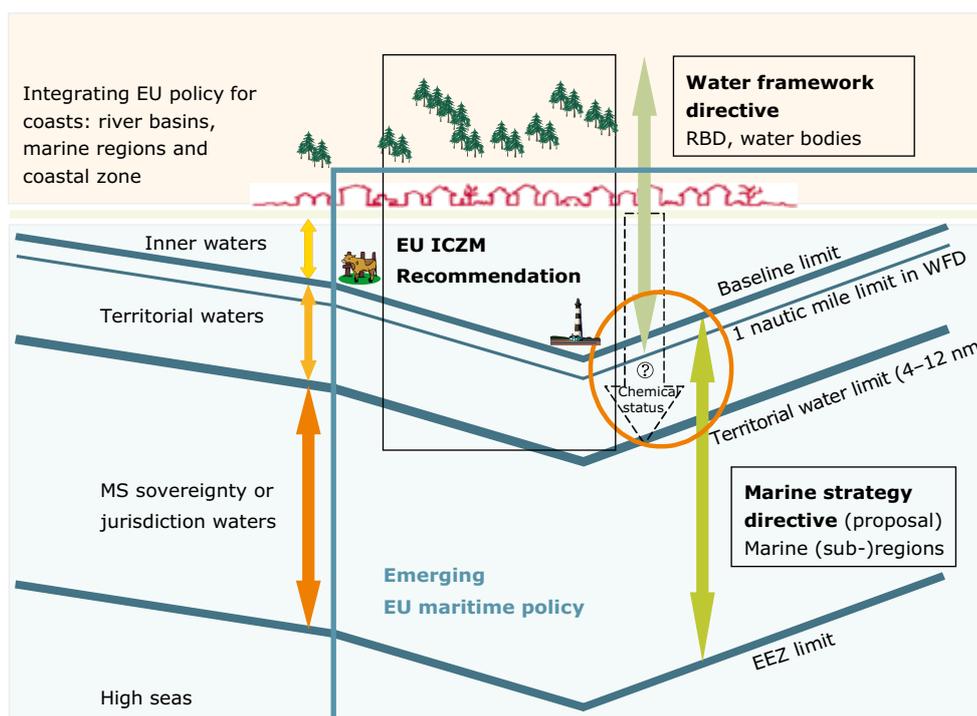
In combination with policy frameworks, such as ESDP, SDS, 6th EAP and funds for regional development and cohesion, the EU's ICZM Recommendation provides the policy integration platform on which to base other directives relevant to the coast, in particular the water framework directive (coastal and transitional waters), the birds and habitats directives (Note: eight of the forty designated priority habitats are coastal) and environmental impact assessment directive (Annex III demanding EIA for development projects on the coastal zone). These directives all address the sea/land interface.

In particular, the integration of the water framework directive (WFD) and the EU's ICZM Recommendation provide opportunities for coupling coastal zone management with catchment basin management. Such freshwater-marine system coupling has resulted in lower pollutant loads and improved conditions in estuaries. However, due to

the complexity of the marine system, even larger-scale integrated management initiatives are required for the effective management of coastal and marine systems over the long-term (MEA, 2005b). This requires continuous coordination and synergy of WFD with the European marine strategy and the creation of the legal grounds for the catchment-coastal continuum. This seamless vision of land-sea interface that incorporates coastal systems should serve as a sound foundation on which to build the environmental pillar of an emerging EU maritime policy (Figure 18).

Conventions of European regional seas in the development of ICZM tools also play an important role. These conventions have promptly initiated action plans and a pilot site study on the integrated management of the coast. Nature Protection and Biodiversity Group of the Helsinki Convention (Helcom HABITAT) addresses the ecosystem approach and ICZM in the Baltic Sea (Helcom Recommendation on ICZM). Recent developments in the Barcelona Convention could represent a good opportunity for the implementation of ICZM in the Mediterranean (i.e. through a draft protocol on ICZM). The synergies of the European marine thematic strategy with regional seas conventions are a crucial element of effective implementation, as the European strategy does not foresee any concrete target measures. Therefore, operations and implementation will be carried out at regional level.

Figure 18 Integration model of river basins, marine regions and coastal zones



4.2.3 Role of structural funds and the cohesion fund

Structural funds will provide significant financing of the Natura2000 network through the LIFE+ support. They are also intended to stimulate structural changes (e.g. development of tourism) and encourage the economic growth of coastal regions. The funds allocated to coastal regions have been considerable and have already had significant effects. For example, the European Regional Development Fund alone has provided EUR 2 billion for port development in the period 2000–2006. Cohesion funds will try to revitalise economies in peripheral coastal regions, for example, in all coastal regions of the EU-10.

Cohesion funds should be an important tool for ensuring that coastal practices move in the direction of ICZM. So far, they have emphasised infrastructure, linking it with regional development, internal market and convergence goals. Infrastructure, in turn, has a major effect on the urbanisation and occupation model of coastal space. Thus, care should be exercised in order to avoid hitting the carrying capacities, as is the case in some regions of southern Europe. Frameworks, like ESDP, could facilitate guidelines for further spatial planning at regional level.

By adopting its legislative proposals for cohesion policy reform 2007–2013 (COM(2004)492–496), the European Commission put more environmental emphasis on EU Structural Funds and the Cohesion Fund. This should assist in ensuring compliance with the environmental standards established in relevant directives. By directing structural assistance to projects which reduce coastal risks, addressing natural hazards and promoting spatial planning can be integrated. Cohesion strategies should strengthen regional sustainable development strategies.

In the EU Fishery Fund there is a priority axis for ICZM. This is oriented towards the communities who are dependent on small-scale fisheries, and is an important legal tool for giving fishing communities their place in the governance process. Member States could create this capacity building in their national strategy on ICZM.

4.3 Climate change, coastal risks and ICZM

Europe is particularly exposed to the sea in terms of the very high ratio of EU coastline length and territory, the proportion of population living by the coast and the amount of extensive low-lying coastal areas, especially in the north-west. All these factors combine to increase the level of risk on the coast. Moreover,

the vulnerability of human and natural systems on the coast has increased due to development, coastal squeeze and the chronic deficit of sediment balance.

The EC communication 'Winning the Battle Against Global Climate Change' (COM(2005)35 final) warns that a 1.4 °C temperature rise would put 10 million people at risk to coastal flooding; a 3.2 °C would put 80 million at risk. This document also recognises the role of land use changes in increasing the pressures on coastal areas and other vulnerable areas, including low-lying coasts and areas at high risk from an increasing number of storms. These areas should be considered as priorities for action in adapting to climate change. In this context, the European Commission's planned new phase of the European climate change programme (Green Paper expected in late 2006) is relevant.

Integrated Coastal Zone Management has been widely recognised and promoted as the most appropriate process for dealing with current and long-term coastal challenges, including climate change and sea level rise. It is a proactive policy process aimed at addressing conflicting interests for coastal space and resources, as well as finding the balance between short-term economic and long-term environmental interests. ICZM also provides the broader context of coastal management when responses to climate change are implemented (Nicholls and Klein, 2005). Current non-climatic pressures may have adversely affected the coastal system's integrity and thereby its ability to cope with additional pressures of climate change. Therefore, improving coastal zone management for non-climatic reasons will also have benefits in terms of responding to climate change. By adequately addressing short-term responses to current pressures, ICZM has the potential to reduce the vulnerability of coastal zones to climate change (WCC'93, 1994).

Based on findings by ELOISE researchers group (Rochelle-Newall *et al.*, 2005), the following critical measures are necessary for more sustainable development of Europe's coasts:

- Adaptive management of human values versus natural systems should be adopted.
- Priority should be given to sustaining and enhancing natural buffers, instead of depending on artificial coastal defences.
- Strategic land use planning should be implemented.

- Disaster preparedness should be considered through the development of relevant sections in the national climate change adaptation strategies and flood risk management systems (EEA ⁽⁴¹⁾).

The role of climate change and resulting coastal impacts are not specifically mentioned in the Commission's communication on Integrated Coastal Zone Management: a Strategy for Europe (COM(2000) 547 final). However, coastal flooding and erosion are recognised as important issues, especially for coastal protection.

However, in 2002 the EU's ICZM Recommendation clearly acknowledged the role of climate change in identifying the need for ICZM. It stated, 'Community coastal zones are further threatened by the effects of climate change, in particular rising sea levels, changes in storm frequency, strength and patterns, and increased coastal erosion and flooding.' By recognising the dangers of sea level rise, and the increasing frequency and violence of storms, the Recommendation refers to the threat to coastal zones posed by climate change as the basis for a strategic approach on ICZM.

In its recent communication on flood risk management (COM(2004)472 final), aimed at the European action programme, on integrated flood prevention, protection and mitigation, the Commission admitted

that coastal areas are at risk of flooding. In addition to direct economic and social damage, floods may have severe environmental consequences, for instance, when waste water treatment plants are inundated or when factories holding large quantities of toxic chemicals are also affected. Floods may also destroy wetland areas and reduce biodiversity.

Flooding of coastal areas can result from storms at sea with winds pushing high tides on to land. In many areas, susceptibility to floods has increased due to coastal erosion. If marine storms coincide with high waters in estuaries then there is the potential for extensive damage. Moreover, due to global warming the frequency and severity of flood events is likely to increase significantly. The problem can only be tackled comprehensively through concerted action in each affected river basin and coastal area. The assessment of prevention and effects of flooding should also be tackled from a spatial perspective, given the clear linkages between natural processes and risk. However, further efforts should also be devoted to the management of natural disaster emergencies, working towards better planning and refining of protocols in health and safety of the population.

Among the key principles of flood risk management, the Commission mentions flood risk management plans and flood risk maps. Coastal flood risk management plans should be developed within the

Box 26 Risk from coastal flooding – UK case study

On the night of 31 January 1953, the east coast of England suffered one of the worst floods in living memory. It has been described as the worst national peacetime disaster to hit the United Kingdom. Exceptional weather conditions, coupled with poor communications meant that whole communities were given insufficient warning of the advancing threat.

The coastal floods of 1953 were largely caused by what is known as a 'storm surge'. Throughout the evening, freak winds and a swelling tide pushed sea levels to nearly three metres above the normal high water mark levels. Flood defences were breached by huge waves and coastal towns in Lincolnshire, Norfolk, Suffolk, Essex and Kent were devastated as sea water rushed into the streets. Over 300 people lost their lives and over 24 000 houses were flooded. Around 40 000 people were evacuated from their homes. Many of these had to sit out the freezing cold night on their rooftops, awaiting rescue. The subsequent clean up operations took weeks to complete and huge cost were incurred.

January 2003 marked the 50th anniversary of those events. Although major advances in flood protection have been made since then, the danger of coastal flooding remains high. In particular, the effects of climate change mean that the chance of storms and high tides occurring simultaneously has increased. Today, nearly one million homes and businesses in England and Wales are at risk from coastal flooding. However, the risk of a disaster on the scale of the 1953 floods has been significantly reduced due to the millions of pounds spent on flood defence and warning systems.

Source: Environment Agency of England and Wales (See www.environment-agency.gov.uk/subjects/flood — accessed 09.02.2005).

(41) http://reports.eea.eu.int/technical_report_2005_1207_144937/en/EEA_Technical_report_7_2005.pdf — accessed 01.03.2006.

Box 27 Green Week 2005

Climate change will dramatically re-shape the natural conditions that prevail in regions across Europe. Yet today's plans that frame human activities for years to come hardly take into account our future climate. How should spatial and regional planning change to incorporate climate change? Ways need to be found to guide development that will match future climatic conditions and avoid the unsustainable high risks or costs due to inappropriately located activities and investments. At the same time, mitigation solutions require space allocations. To what extent can planning respond to the challenge? What is Europe's role in these issues? These were the issues put forward on the session on planning and climate change in Green Week 2005, which focused entirely on climate change. The session also discussed opportunities offered by the new Cohesion policy to fund actions to mitigate or adapt to climate change. Another session with relevancy to coastal zones dealt with the role of European cities in combating climate change. The key question there was: 'How can cities respond adequately to a changing climate in order to protect their citizens and their economies?' The issue of climate change risk reduction through disaster preparedness, disaster response, disaster recovery, disaster mitigation and development was also the topic of talks of Green Week on the sustainability of insurance strategies.

same time frame as flood risk management plans for rivers. These should be fully integrated into the river basin management plans and programmes of measures developed in accordance with the water framework directive. Flood risk maps should clearly define the flood risk zones to give input to strategic and normative spatial planning.

Coastal floods and climate change are addressed by the recent ESPON report 'The spatial effects and management of natural and technological hazards in Europe' (ESPON (42)). In the report, they are more specifically addressed through analyses of storm surges (i.e. sea level rise due to prolonged onshore winds) and winter storms (i.e. regional extra-tropical cyclones as a result of differences in temperature between the polar air masses and the air in the middle latitudes in autumn and winter). Their probability of occurrence is highest in coastal areas of north-western Europe (e.g. the United Kingdom, Norway, Denmark, the Netherlands and Germany). The occurrence as well as the magnitude of winter storms decreases to the east and south (e.g. Sweden, Finland, Baltic countries).

Although not mentioning ICZM specifically, the Commission's communication 'Towards a Thematic Strategy on the Urban Environment (COM(2004)60 final)' is highly relevant to coastal management, as it emphasises the role of sustainable urban design. Besides urban design, the communication mentions climate change, which may imply that current plans for new areas of settlement are no longer appropriate, i.e. due to the risk of flooding. Member States are encouraged to ensure that their land use planning systems achieve

sustainable urban patterns and take into account environmental risks. The communication also stresses the need to evaluate the consequences of climate change for cities, so that inappropriate development is not commenced and adaptations to the new climatic conditions can be incorporated into the land use planning process.

The covering of soil for housing, roads or other land developments is known as soil sealing. As stated by the Commission's communication, 'Towards a Thematic Strategy for Soil Protection' (COM(2002)179 final), the development in soil sealing is largely determined by spatial planning strategies. Unfortunately, the effects of irreplaceable soil losses are often not sufficiently taken into account here. Paramount examples prevail in coastal areas of the Mediterranean where the share of zones completely free of construction is in permanent decline. These developments eventually tend to exacerbate the problem of coastal erosion with high environmental and economic costs. Coastal erosion is not specifically addressed in the communication, but an indirect link to ICZM is suggested. It is implied that land use policy can play an important role in protecting soil resources by limiting soil sealing and ensuring that soil characteristics are taken into account in decisions concerning allocation and use of land.

In conclusion, the challenges of climate change need to be well understood and clearly addressed in policy documents relevant to ICZM. The EU's ICZM Recommendation is clear on these issues. Since its publication in 2002, several other studies and policy documents have supported these views.

(42) <http://www.gsf.fi/projects/espon/Finalreport.pdf>, accessed 15.11.2005.

In terms of responding to the challenges posed by climate change, several principles for development of national ICZM strategies address them such as a long-term perspective and precautionary principle, adaptive management, accounting for diversity of local conditions, working with natural processes

and coherence between planning and management. Nevertheless, climate change will increasingly challenge the existing ICZM policy framework and will stimulate sustainable spatial planning and resource management of the coastal areas as a response.

5 Building the conceptual framework

5.1 Towards an integrated assessment framework

On the coast, most processes (e.g. physical and socio-economic) occur over relatively short timescales. Coastal space is representative of highly complex processes involving ecosystems, temporal and spatial scales, interests and responses. All these levels need some potential integration in order to avoid unsustainable development and the degradation of the coasts and their inhabitants.

Conventionally, coastal problems have been tackled by sectors on an individual basis. It is evident that a new vision is needed in order to get an integrated understanding of what is happening in the entire coastal system. Integrated management of coasts requires integrated information and the creation of a common knowledge base. This involves data collection methods and the development of specific coastal operational frameworks, which are relevant at all levels of coastal management.

The emerging regional conception of coastal areas and coordinated data collection will allow for better 'visibility' of the coast as a unique living space, its threats and opportunities. Increased visibility in terms of policy attention may then change social perception and prepare the ground for sustainability. Such a baseline will also serve to assess policy implementation and their effects on the coast.

The high level of complexity of coastal areas is particularly illustrated by the existence of simultaneous and spatially overlapping, complex, natural coastal systems and the number of coastal stakeholders with divergent interests.

The sufficient integration of environmental concerns into social and economic policies, supported by effective spatial planning and trans-boundary integration, is still a challenge, especially if a holistic vision for the coast (including across sea/land interface) is to be a goal.

Vertical integration from EU level to regional and local level has to be addressed in order to find the

right balance of policy measures and the method of implementation of integrated action for the coast.

Without achieving significant progress in conceptualising coasts in terms of administrative vision, regional space entity and relevant data collection scheme knowledge about coasts will remain scattered and disaggregated. As a result, the coast and related problems will not receive the appropriate public and policy attention. This directly implicates the data availability and quality of information used for assessments of coastal zones, in a multi-scaling context.

The current assessment demonstrates the possibilities and potential of spatial integration and GIS analysis, based on a land accounting method and a combination of different indicators. However, a great deal of work still needs to be carried out.

5.2 Spatial analysis of anthropogenic pressures

Detailed insight of human pressures on Europe's coasts is only possible at regional and local level. The case study of a Natura2000 site in Portugal served as an attempt to show the spatial analysis of anthropogenic pressures inside and around Natura2000 designated areas. It also documented the evolution of these pressures during the period 1990–2000. The role of this exercise is to demonstrate the potential of GIS and spatial analysis in the assessment of anthropogenic pressures in coastal zones, and contribute to developing the methodology of coastal assessments.

The Sudoeste Alentejano e Costa Vicentina National Park is located between the districts of Beja and Faro in the south-west region of Portugal and is a protected coastal area (Natura2000 site). It is home to approximately 200 species of birds, rare mammals and amphibians. Species to be found here include: the osprey, Bonelli's eagle, white stork, peregrine, genet, weasel, Iberian lynx, otter, spotted salamander and the tree-frog. The park has been inhabited since the Palaeolithic period, and has

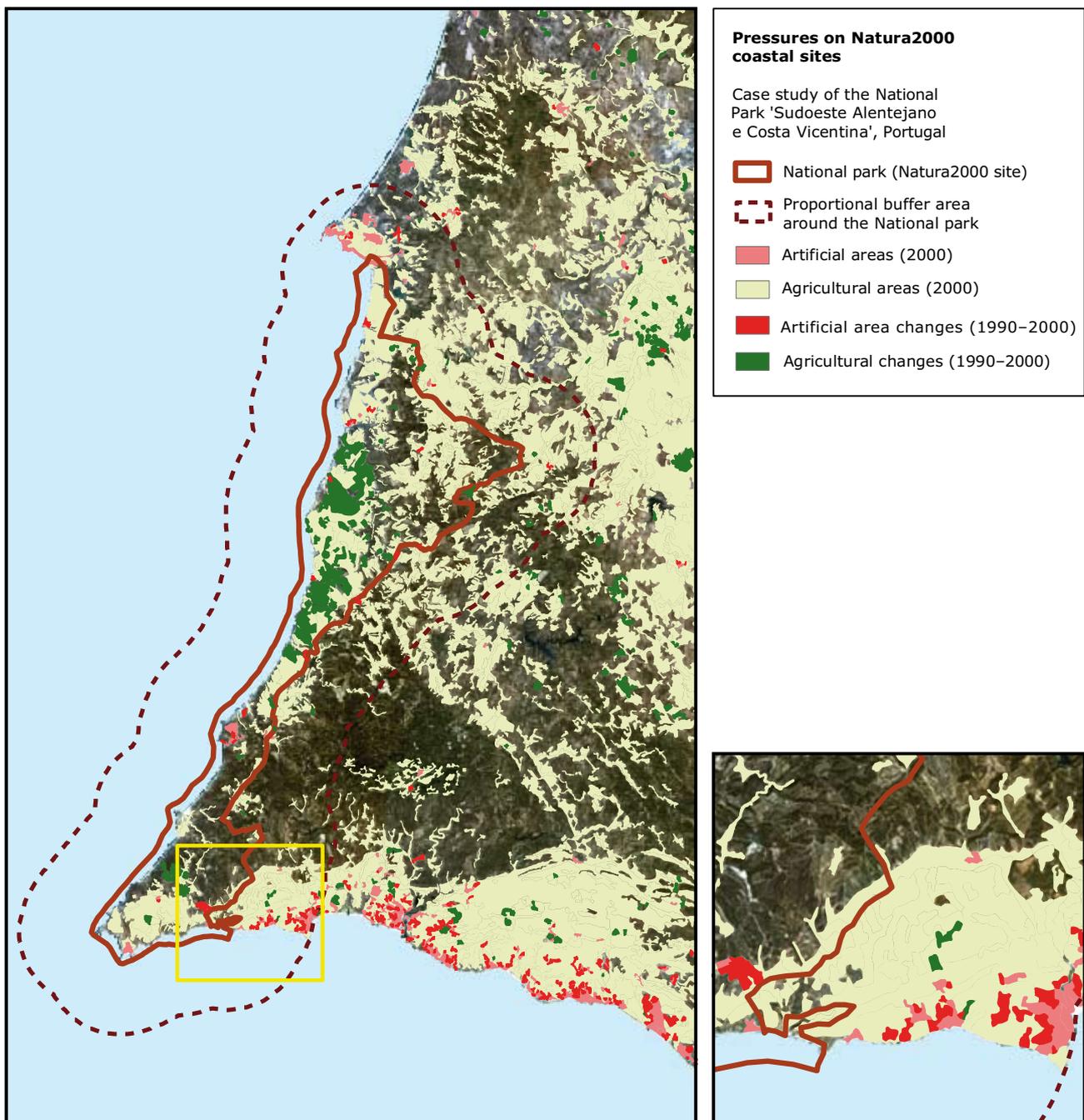
a rich cultural heritage. However, there are only a few major historical buildings here. The park's landscape is made up of cliffs and gorges, beaches, small islands and isolated rocks. Furthermore, the island Ilha do Pessegueiro, near Porto Covo, is an important tourist destination.

The area of this Natura2000 site is 1 182 km²; 85 % of which is land surface. Artificial areas make up 1.40 % whereas agricultural land covers 50.5 % of

the Park's territory (2000). Agricultural practices are normally extensive, and based on traditional methods.

The National Park of Sudoeste Alentejano e Costa Vicentina was created by the Portuguese Decree 26/95 (September 21 1995). Even though the area was not officially made a national park until 1995 there were already different regulations in place to maintain the natural environment. The national

Map 19 Sudoeste Alentejano e Costa Vicentina National Park – anthropic pressures



Source: EEA, 2005.

park was created to protect the area against the growing industrialisation of Sines (in the north) and the possibility of urban sprawl spreading from the Algarve Region (in the south). From 1990 to 2000 'critical' changes (e.g. industrial areas) were relatively low. Only a few hectares were effected in the industrial area of Sines.

However, artificial areas have been increasing and agricultural lands have been decreasing for both the designated site and its surrounding area between 1990 and 2000. Interestingly, in relative terms, the protected site has experienced slightly faster growth of artificial areas and slower abandonment of agricultural land than the areas around it.

This may be explained by the location of Sines and other small villages along the protected coast, where residential areas resulting from tourism development are increasing in a similar fashion to Portimao and Lagos, southern Algarve.

The principal reason behind the reduction in agriculture is the decrease in population in the whole area. Agricultural support from the EU has not changed this trend. The area of the national park has no modern infrastructure network. This is good for the environment but not for supporting traditional lifestyles in rural areas. Poor access to services has influenced population migration from the countryside to the principal regional cities of Alentejo, Algarve and Lisbon over the past decade. Isolated areas without up-to-date infrastructure and without sufficient governmental support have difficulty holding on to their communities. Therefore, the resulting abandonment of the national park and the surrounding areas does not support the real protection objectives of the park and its habitats.

The overall development path of the area is clear. At the beginning of the 1990s the regional economy was principally based on inland agriculture, whereas today it is increasingly based on coastal tourism.

This follows the same patterns as in the Algarve region.

5.3 Lessons learnt: data gaps and needs

Spatial assessment at European level is severely limited by the availability of harmonised European data sets. Annex Part A presents an overview of the main data sources and problems associated with these data sets. More specific requirements for updating the information base are related to the following data improvements:

- temporal coverage (as a minimum two dates for change analysis);
- spatial coverage (maximum coverage of European countries);
- thematic coverage (digital elevation model, status of ecosystems, marine traffic and ports data; data relevant to sea level rise and climate change etc.).

Spatial demarcation of the coast should be clearly defined at the GIS technical level. Also, river basin boundaries should be well coordinated with marine catchments and with the different physical and legal sea boundaries. These boundaries include:

- bathymetry and the limit of the sea continental shelf;
- coastal water as defined by WFD (i.e. one nautical mile off baseline from which the extent of territorial waters is measured);
- national territorial waters having consistent coastal units (for Europe, by regional sea, by countries, by sea fronts, by NUTS units for integrating socio-economic data, by dominant landscape types etc.).

There is a need to analyse these different units using the land and ecosystems accounting (LEAC) database on trends in land, ecosystem and water. There are serious information gaps identified on

Table 4 Artificial and agricultural pressures 1990–2000 inside and surrounding the Natura2000 site in Portugal

Sudoeste Alentejano e Costa Vicentina National Park (Portugal)	Area (ha)	Anthropogenic classes			
		% artificial		% agriculture	
		1990	2000	1990	2000
Natura2000 site	118 248	0.87	1.40	52.69	50.50
Surrounding buffer area	241 881	1.63	2.07	44.88	41.59

Source: Corine land cover 1990 and 2000.

the marine side of the coast, e.g. regional pollution loads into the sea, quality of coastal water bodies, distribution of marine habitats, status of key benthic species communities and the mapping of numerous offshore use activities. These data exist at regional level in most of the cases but it is difficult to see consistent spatial coverage at EU level. Cooperation with JRC/IES (chlorophyll-a assessments) and GMES fast-track service elements may provide spatially distributed data of coastal water turbidity (i.e. exceed the threshold of suspended matter in sea water) and transparency (equivalent to Secchi disc depth) as approximations for coastal water quality.

There have been cases when data needed for coastal assessment at regional and local level are not easily available and free of charge (e.g. the precise location of habitats and species in critical 'hotspot' areas).

Similar future work may very much benefit from INSPIRE implementation. Action should be taken to ensure a good data model for the coast. The model should link land and sea, and integrate all regional and national databases into a European coastal platform. This would serve the implementation of INSPIRE principles (e.g. the establishment of Spatial Data Interest Community for coasts). Such a future coastal database should also include statistics on sectoral aspects expressed in spatial terms. This information is urgent and needed to serve the development of more efficient integrated policies for the coast. However, it should focus on the assessment needs at European level and avoid duplicating relevant data structures at regional and national level.

A further element in data needs is related to the improved spatial resolution of the data available for assessment. However, the increased spatial resolution is not a goal in itself, because for assessment on a European level the most detailed data is not appropriate. Thematic resolution is also an issue, i.e. different data layers included in spatial assessment. An appropriate balance in thematic (and spatial) resolution of the data between European and local/regional levels is needed to achieve a sound multi-scalar approach. For example, the relevancy and amount of individual data layers used to describe more local phenomena are larger. This makes it possible to address the situation in sufficient detail for local needs and for responsive coastal management issues. There is a challenge for the research community to create such sound data up/down scaling methodology, especially if adapted to the context of coastal areas.

The concept of coastal conflict (i.e. an area of accumulating problems due to overlapping interests for coastal space or resources) can be used in monitoring the most critical areas. One aspect of this concept is also related to spatial data resolution problems. Applying the coastal conflict concept would allow selection of European coastal areas, where the investment for creating 'zoom in' is justified, i.e. more detailed data sets for selected areas of the most pronounced problems.

New additional data for the coast are expected as the results of a number of projects become available in late 2006 and 2007. They will be of key benefit for the whole coastal community. The projects are highlighted in the INSPIRE implementation work programme published in July 2004, and include RISE, MOTIVE (Marine overlays on topography), ORQUESTRA, Eurospec, EU-FLOOD-GIS and INSPIRE pilot projects. In addition, the on-going development of the EEA's own elements of ESDI (European Spatial Data Infrastructure) will offer updates of the Corine land cover database. Reports from Member States and Interreg (DEDUCE, COREPOINT) will also be available by that time for indicator development.

These activities warrant full consideration as they offer regular assessments, which are critical for reporting on progress. Further studies could make use of many new information sources and will assess changes of the baseline situation recorded by the current report in 2006.

5.4 Communicating main environmental problems

The problem of the coast's low 'visibility' in the policy making process has been noted for some time. To a large extent this is justified by the high level of complexity of the coastal context which makes it difficult to design straightforward and manageable policy solutions. The absence of a sound conceptual framework for coastal assessment is only adding to this problem. But there is also the issue of insufficient communication. 'Coastal zones' needs its 'own story' — a good, clear summary of coastal problems and the main options for avoiding unsustainable development patterns. Such a storyline has to merge the key ingredients of the coastal context into an easily understandable presentation.

More precise, high quality, reliable assessments need to be combined with more effective communication to the wider general public and

decision makers. Media monitoring of coastal and marine environmental issues should be carried out, as media coverage affects public awareness and consumer behaviour.

How can one find the right angle to communicate most effectively the coastal story? As long as coastal experts continue to concentrate their efforts on debating the most relevant issue on the coast, then opportunities for getting the attention of the general public and decision makers will be lost. The 'political visibility' of coastal zones is not improving and policy attention remains low.

ICZM, in this context, represents a good opportunity because it can help Member States to promote better coastal awareness. In 2006 Member States have to deliver their national strategy on ICZM. Answers to a DG ENV questionnaire on the development of the ICZM strategy gave the results shown in Table 5 (September 2005).

Sustainability indicators for coastal areas, such as those set by the WG-ID of the EU's ICZM Expert Group, provide a powerful mechanism for delivering the 'state of the coast' message and major

trends to policy makers and the general public. In order to promote the role of indicators as a communication tool within the ICZM process and eventually attain the validated suite of sustainability indicators for Integrated Coastal Zone Management, these indicators need to be tested.

Understanding ecosystems is difficult for the general public. Nevertheless, the well-being of ecosystems is essential for people's quality of life. People can understand what happens when a beach is eroded or when a storm destroys coastal dunes and forests. Communication is therefore of prime importance to link scientific and technical knowledge with the living landscape and to show how changes often come about as the result of a series of small decisions made at local level.

5.5 The role of this report

This piece of work constitutes the EEA's first coastal assessment report with a methodological focus on integrated spatial assessment at European level. Besides demonstrating some of the current trends affecting Europe's coasts, the report aimed

Table 5 Overall progress on EU ICZM Recommendation implementation (2005)

	Number of coastal Member States	Representing x km of the EU coastline (ref. EuroSION coastline definition)
Development of an ICZM strategy	9	64 635
Development of additional action, to promote ICZM	7	18 332 (18 %)
Undecided	1	4 578 (5 %)
No reply	3	13 260 (13 %)
Total	20	100 805 (100 %)

Source: DG-ENV/ICZM Expert Group.

Box 28 Chesapeake Bay

Chesapeake Bay, an estuary on the US Atlantic coast, has been under restoration since 1983. However, little has been achieved. Conservationists know what is wrong with the bay and how to fix it. They also know why it is not a happening. The reason is that attention and resources have been given solely to technical solutions, such as urban waste water treatment. Despite success in these areas, Chesapeake Bay shows very weak signs of improvement from eutrophication. The levels of nitrogen and phosphorus have either remained the same or increased due to agricultural discharge, land sealing and related urban storm waters, diffuse residential pattern (i.e. urban sprawl) and the gradual reduction of natural and semi-natural lands. As these factors cannot be controlled by technological measures alone, improvement has been slow in coming. The key to repairing the ecosystem is to inform the population and promote ownership of the problem among the general public. In other words, they should want to care for 'their' Chesapeake Bay.

Source: Horton, T., 2005.

to provide a value-added contribution towards the development of a conceptual framework for coastal (or regional) assessments.

It is the first baseline to assess the main environmental concerns on Europe's coasts. Construction of an acceptable data model for the coast of Europe and its regions will make it possible to have a more complete update after 2006. It will also contribute to the implementation of the EU's ICZM Recommendation at national level, and help to develop a new phase in coastal policy.

This report adds value because it brings a spatial perspective and integrated vision to the current

debate. Socio-economic aspects are nested within each issue and covered in the synthesis chapter. Nevertheless, due to limited comparable and organised data, the report does not fully cover all relevant interactions with environmental issues.

A link between the implementation of ICZM principles and the state of coast in terms of sustainable development and coastal management practice is addressed as much as possible. However, the main methodology for assessment is analysis of spatio-temporal trends in coastal zones. This methodology looks at the interaction between land cover, ecosystems and coastal water within the framework of existing policies.

List of acronyms

Term	Meaning
CG	Guide values (bathing water quality directive)
CI	Mandatory values (bathing water quality directive)
CNADT	National Council for Territorial Management and Development
CLC	Corine land cover
CPMR	Conference of Peripheral Maritime Regions
CSI	Core set of indicators
DATAR	French Delegation for the Territorial Planning and Regional Action
DEDUCE	Interreg IIIC project (Developpement Durable des Zones Côtières d'Europe)
DEM/DTM	Digital elevation model/digital terrain model
DG	Directorate General
DG ENV	Directorate General of the Environment (European Commission)
DMSP/OLS	Defence Meteorological Satellite Program/Operational Linescan System
DLT	Dominant landscape type
DPSIR	Driving forces, pressures, state, impact and responses
EAP	Environmental action plan
EC	European Commission (CEC — the Commission of the European Communities)
EEA	European Environment Agency
EFTA	European Free Trade Association
Eionet	European environment information and observation network
ELOISE	European Land Ocean Interaction Studies
EPA	Environmental Protection Agency
ESDI	European Spatial Data Infrastructure
ESDP	European Spatial Development Perspective
ESPON	European Spatial Planning Observation Network
ETC-TE	European Topic Centre on Terrestrial Environment
ETC-BD	European Topic Centre on Terrestrial Biodiversity
ETC-W	European Topic Centre on Water
EU	European Union
EUNIS	European Nature Information System
EUR	Euro
Eurostat	The Statistical Office of the European Communities
EWEA	European Wind Energy Association
GDP	Gross domestic product
Gencat	Generalitat de Catalunya
GIS	Geographic information system
GISCO	Geographic information system of the European Commission
GMES	Global monitoring for environment and security
GTK	Geological Survey of Finland
Helcom	Helsinki Commission

ICZM	Integrated Coastal Zone Management
IFEN	French Institute for the Environment
IFREMER	French Research Institute for Exploitation of the Sea
IFOP	Financial Instrument for Fisheries Guidance
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Prevention Pollution Control (Directive)
INSPIRE	Infrastructure for spatial information in Europe
Interreg	Community initiative concerning border development, cross-border cooperation and selected energy networks
ISA	Integrated spatial assessment
ISEMAR	Superior Institute of Maritime Economy
ITOPF	International Tanker Owners Pollution Federation Limited
JRC	Joint Research Centre (European Commission)
Lacoast	Land cover changes in coastal zones
LEAC	Land and Ecosystem Accounting
LIFE	EU Financial Instrument for the Environment
LME	Large marine ecosystems
LOICZ	Land-Ocean Interactions in the Coastal Zone (project)
MEPA	Malta Environment and Planning Authority
MW	Million watts
MTS	Marine thematic strategy
NASA	National Aeronautic Space Administration
NCMR	National Center for Marine Research (Greece)
Natura2000	EU network of designated areas
NUTS	Nomenclature of territorial units for statistics. This abbreviation is only applicable to EU members. Level 3 corresponds to regions.
OECD	Organisation for Economic Co-operation and Development
OSPAR	Commission for the protection of the Marine Environment in the North-East Atlantic
PAP-RAC	Priority Actions Programme/Regional Activity Centre
RBD	River basin district (relevant to WFD)
SCIs	Sites of Community interest
SD	Sustainable development
SEA	Strategic Environmental Assessment Directive (2001/42/EC)
SoE	State of the Environment
SPAs	Special protection areas
TBT	Tributyltin
UNEP	United Nations Environment Programme
VASAB	Vision and Strategies around the Baltic Sea 2010
WFD	Water framework directive
WG-ID	Working Group on Indicators and Data

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Annex: Data and methodological approaches

A Data and methodology of the report

Analytical framework

The analytical framework of this report is defined by following boundary conditions:

- relevancy to EU policies, directly or indirectly aiming at the coasts;
- focus on European level (coastal EU Member States and new accessing countries);
- environmental perspective as an entry point for analysis;
- spatial assessment and availability of spatial data;
- trends of spatial change;
- comparative assessments of European regional seas;
- integration of spatial data sets and other coastal indicators (research, statistics) in a spatially distributed frame (GIS).

GIS has a specific role in this assessment, because most of the practical results are produced through spatial analysis and by using the GIS for data integration.

Regional delineation of Europe's marine waters also influences the analytical framework of coastal zone assessment. This report presents the trends along Europe's coasts by aggregating them for the Baltic Sea, the North Sea, the North-East Atlantic Ocean, the Mediterranean Sea and the Black Sea. However, follow-up work should focus more on the ecosystem view of the European marine and coastal environment. Further assessments may benefit from establishing legally defined European Marine regions and sub-regions (nine in total for EU marine waters, according to the current proposal of marine strategy directive). On a pan-European scale the basis for regional assessments is provided by 13 large marine ecosystems (East Greenland Shelf, Barents Sea, Norwegian Shelf, North Sea, Baltic Sea, Celtic-Biscay Shelf, Iberian Coastal, Mediterranean Sea, Canary Current, Iceland Shelf, Faroe Plateau, Black Sea and Arctic Ocean).

Data availability

There is a deficit of harmonised, consistent and compatible European spatial data relevant to the coasts. The assessment takes stock of all relevant spatial data that are available at EU level at the time of drafting this report. The challenge is to connect the different types of data into one database for the coastal zone of Europe and build a set of coastal indicators.

The report benefits from many available data and information sources, such as statistical, geo-spatial, the EU's ICZM Expert Group WG-ID indicators, expert networks, EEA indicators, and scientific data from different European projects and initiatives. Data are integrated into a common spatial framework. The work also includes a dialogue with scientists and coastal stakeholders, so that it can be as up-to-date as possible and take into account the diversity of European situations and contexts.

European data sources

The core information used for the spatial assessment of the coasts at European level is the result of analysis from several existing and accessible databases (details in table below) (more information in the EEA data service ⁽⁴³⁾):

- LaCoast database
- Corine land cover 1990
- Corine land cover 2000
- Corine coastal erosion
- Natura2000 database
- EuroSION database

The following table provides an overview of availability, access conditions, temporal and geographical coverage, and some other parameters of the databases used for the main spatial data processing and analysis.

All data sources, GIS manipulation and methodological procedures used in this report have

⁽⁴³⁾ <http://dataservice.eea.eu.int/dataservice> — accessed 23.11.2005.

Databases available for this report

Data source	LaCoast database	Corine land cover 1990	Corine land cover 2000	Corine coastal erosion	Natura2000 database	EuroSION	
Data custodian	JRC	EEA	EEA	EC/EEA	DG ENV	DG ENV	
Status	Finished	Finished	Finished	Historical	Version 2004	Finished in 2004	
Responsible authority	JRC and DG ENV	European Commission – DG Environment, Nuclear Safety and Civil Protection	EEA	EEA	DG ENV is the owner of the database. Management by ETC-BD	DG ENV	
Period	Start date	1975–1976, depending on the country	1986	1999	1985	Starting network in 1992	January 2002
	End date	1986–1995, depending on the country	1995	2001	1990	On-going	May 2004
Data availability	100 %	100 %	100 %	100 %	100 %	Depending on the layer	
Geographic coverage	10 Member States of the EU (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain)	EU-25 (with the exception of Finland, Greece, Sweden, United Kingdom, Cyprus, Malta), Bulgaria and Romania	EU-25 Member States of the EU and Liechtenstein	EU-12 Member States except the Greek Islands, former German Democratic Republic, Madeira and Azores	EU countries (EU-15 plus several EU-10 and accession countries)	EU-15, Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Poland, Romania, Slovenia and European ultra-peripheral regions	
Spatial resolution	Minimum mapping unit 25 ha	Minimum mapping unit 25 ha	Minimum mapping unit 25 ha	Minimum mapping unit 25 ha	Depending on Member States	Depending on the layer	
Temporal coverage	2 periods: 1975–1976 and 1986–1995	1990 +/- 5	2000 +/- 1 year	1990 +/- 5	Depending on Member States	Depending on the layer	
Quality	Accuracy ≥ 85 %	Accuracy ≥ 85 %	Accuracy ≥ 85 %	Accuracy ≥ 85 %	Depending on Member States	Depending on the layer	
Access conditions	Agreed dissemination policy from the start	Dissemination policy available	Agreed dissemination policy from the start	Dissemination policy available	Agreed dissemination policy from the start	Depending on the layer	

been carefully documented in the collection of fact-sheets to allow the transparency and traceability from data source to the results.

Indicators targeting the coast

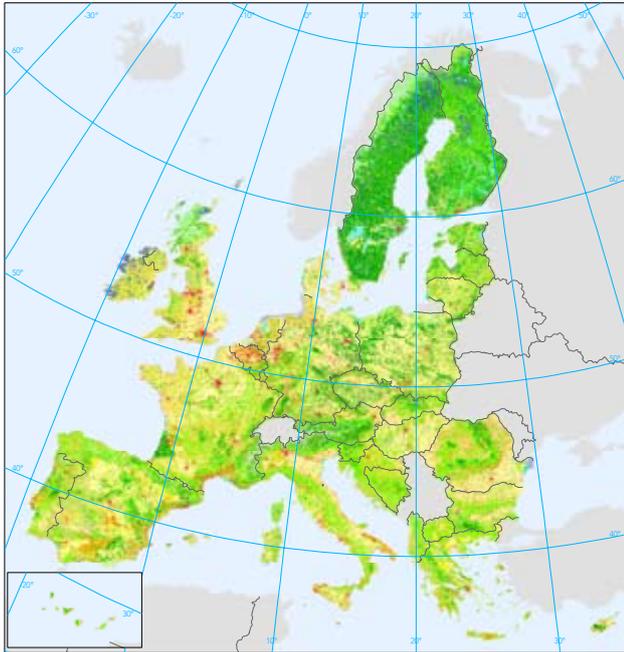
Despite several sustainable development indicators produced over the last ten years (Plan Bleu, OECD, Eurostat and others) only a few focus on the coast. Generally, they are designed for national level use, and do not extract the coastal regions or have a spatially distributed format. They do not serve to illustrate coastal changes.

Driven by the EU's ICZM Recommendation, launched in 2002, specific indicators for the coast are

being produced and tested by the working group on indicators and data set up by the EU's ICZM Expert Group.

Two sets of indicators have been prepared; the first one on progress in implementation of ICZM and the second on the sustainable development of coastal zones. Indicators directly relevant to the coast have also been developed by the EEA topic centres (urban sprawl, designation, water quality) specifically for this assessment. Some projects like GMES CoastWatch (2002–2004) or Interreg IIIC project DEDUCE (2005–2007) have and will also develop indicators in different test areas along the European coast. These will be based on the set identified by the WG-ID Expert Group, and will be correctly

Corine land cover 2000 (June 2005)



Source: EEA, 2005.

geo-referenced, at local, regional, national and European level. This will make it possible to obtain consistent data across different scales, and allow data harmonisation and comparisons. The establishment of a multi-scale indicator system also allows repeated monitoring and timely reporting in the future.

Data developed specifically for the coastal zones is relatively scarce. Therefore, additional data for coastal assessment should be generated by manipulating other 'non-coastal' data sets and indicators, which are developed for national and regional reporting or research projects (population, land cover, Natura2000, point source and river discharges etc.). These additional data have to be extracted from their parent databases and integrated into the general GIS database. This will give coastal data coverage that needs to be organised by coastal assessment units.

Quality requirements for spatial data

Many data sets relevant to coastal zones may only have a limited use because of low spatial resolution. This represents a specific limitation for spatial assessment. There are also other important issues, such as sufficient spatial coverage, temporal resolution and consistency of data formats.

Spatial data quality has direct consequences on the usefulness of spatial assessment. Quality and the

results (trends) is very dependent on the data used. To define clearly what data is used as well as what has not been used will avoid poor interpretations of results and related expectations.

As seen from the table of available European databases, different data sets can have several data gaps in terms of temporal and spatial coverage. This makes it difficult to compare the data herein. As a result, the spatial discordance of data layers often prevents coastal trends from being established. Therefore, efforts to improve the resolution (both temporal and spatial) and harmonization (seamless data) are needed. Data availability due to access restrictions or copyright may also create problems and can be conditionally referred to as data quality issues.

Spatial data integration

Besides spatial analysis tasks, the role of the GIS is to allow different spatially distributed data sets to be integrated into a coastal database. Existence of such a database is a prerequisite for the successful linking of data across the sea/land interface. This is the main challenge for coastal assessment. Due to very different characteristics of both media and respective data collection methods, land and sea related data have rather different properties and tend to be collected in different ways.

An additional challenge is the spatial integration of different socio-economic data, such as data from economic sectors (e.g. tourism, aquaculture, marine transport) or population distribution. These data tend to be organised by administrative units (typically NUTS3 units), while data on water, habitats and land cover is more available in natural units (e.g. catchments, designated areas, remote sensing products).

Local and regional data and related indicators (e.g. the EU's ICZM WG-ID indicators) have to be assembled within European datasets (e.g. Corine land cover, EuroSION, Natura2000). This shows the effect of wider scale pressures on actual state of coasts and respective impacts on biodiversity and human life.

Identifying and modelling 'cause-effect' relationships are even more difficult. This can be carried out to some extent on regional or local scales, but is rather complicated, especially for spatial assessment, at European level.

Land accounts: measuring trends in coastal change

The land and ecosystem accounts method (LEAC ⁽⁴⁴⁾), as developed by the EEA and ETC-TE, provides a framework for analysis of spatial changes in coastal zones. The temporal trends of LEAC land cover flows were determined between 1990 and 2000.

The LEAC application for coasts is used for analysis of land use conflicts in area and time, from local to European scales. It can be used for monitoring development trends of coastal systems. Land cover is an (*ex-post*) image of land use and ecosystems condition and accounts can be compiled in monetary or physical units. Changes in structure, patterns, quantity and quality are included into accounts. Indicators can be easily derived from accounts. Land use relates to many economic and social functions of land, e.g. housing, food production, industrial activities, services, transport, recreation and nature protection.

The main stages of the LEAC application for the coastal assessment can be presented as follows:

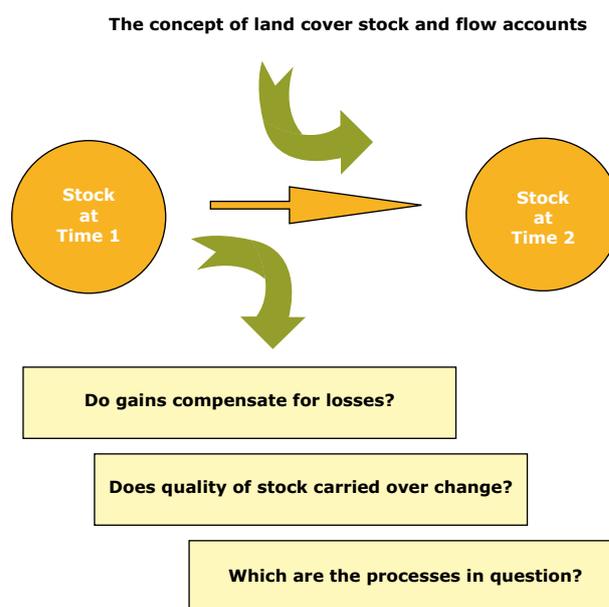
- Stratification of the territory into accounting units:
 - Definition of dominant landscape types as approximations of actual land cover (Box A)
- Calculation of land cover changes:
 - Accounting of land cover stocks
 - Determining land cover changes (e.g. from CLC1990 to CLC2000)
 - Identification of land cover flows (grouping individual changes into processes) (Box B)
 - Processing and classifying data
- Presentation of results

Box A	Classification of dominant landscape types (Level 1)
A1	Urban dense areas
A2	Dispersed urban areas
B1	Broad pattern intensive agriculture
B2	Composite rural landscape
C1	Forested landscape
C2	Open semi-natural or natural landscape
C3	Landscape with no dominant land cover character

Box B	Nomenclature of Land cover flows (Level 1)
LCF1	Urban land management
LCF2	Urban sprawl
LCF3	Extension of economic sites and infrastructures
LCF4	Agricultural rotation and intensification
LCF5	Conversion of land to agriculture
LCF6	Forests creation and management
LCF7	Water body creation and management
LCF8	Changes of land cover due to natural and multiple causes

Based on Corine land cover 2000 database which also contains a special data layer of 1990–2000 land cover changes, the land accounting methodology allows the measuring of land cover stocks at time 1 and time 2, land cover changes (time 2 minus time 1) and land cover flows (relevant to socio-economic land use processes). By publishing this report, land cover accounts have been calculated for most of the EU Member States, where CLC change data is available. So far, the results of land cover change

The concept of land cover stock and flow accounts



⁽⁴⁴⁾ <http://eea.eionet.europa.eu/Public/irc/eionet-circle/leac/home> — accessed 16.05.2006.

intensity are presented in 3 x 3 km cells. The 2006 version of LEAC results will be available in 1 km² cells.

Land account makes the best use of CLC databases. With the new update of CLC database (expected by 2007/2008), a long series of land cover stocks, changes and flows can be carried out for the period since 1975 (parts of Europe).

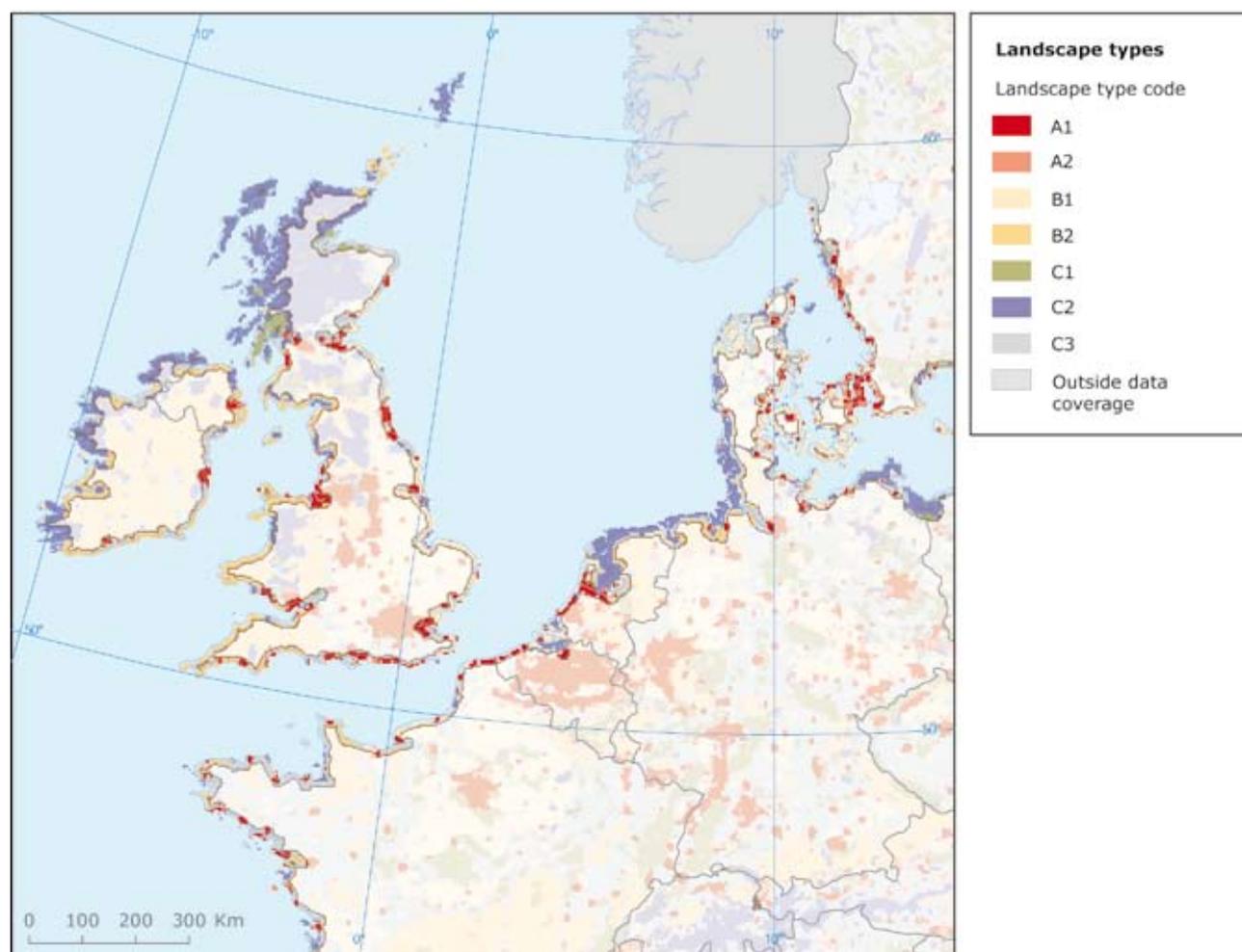
Land stocks are calculated on the basis of 44 classes of CLC. These are for the different reference years and changes grouped into land cover flows. Explanations are given on the example of loss of wetlands (loss of stock and identified change). Loss can be due either to the flow, 'intensification of agriculture', 'afforestation' or 'urban sprawl'. This information, coming from CLC (based on Earth Observation products), can be enriched by the other databases presented in table of available European datasets. For example, by combining the

CLC with Natura2000 data, the LEAC can be used to determine the surface of wetlands protected by Natura2000 and the loss of wetlands observed outside Natura2000 sites.

Statistical data can be included in the LEAC and spatially redistributed on the basis of the land cover types. This gives a better picture of spatial distribution and makes more understandable and measurable the change of the statistical parameter in a determined coastal unit during a certain period of time.

The LEAC analysis has been applied for coastal zones defined as being 10 km from the coastline. This follows the approach developed by the Joint Research Centre (Perdigao and Christensen, 2000). The European coastline is acquired from CLC2000 database. The administrative definition of the coast in this report is based on NUTS3 for EU level and LAU2 (NUTS5) for some case studies.

Dominant landscape types and definition of the coastal extent in LEAC



Source: EEA, 2005.

The role of consultation phases

During the working period 2004–2005, preparations for this paper involved several consultations regarding content, prioritisation of issues, achieving policy relevance and the interest of stakeholders. An overview of the main consultation events is given in the table — consultation process overview.

Integrated spatial assessment platform for the coasts

Integrated management requires integrated information, which is based on an integrated data system. The EEA platform for integrating data on land, biodiversity and (coastal) water is applied for the assessment of Europe's coasts. This platform

Main characteristics of coastal zone from the Corine land cover versus inland in Europe

Country	Coastline length (km) (CLC2000)	Area of 10 km coastal zone (km ²)	Total country area (km ²)	% of 10 km coastal zone vs. total area	% of 10 km coastal zone vs. total area of coastal zones of all countries
Belgium	307	1 920	30 664	6.26	0.34
Bulgaria	501	2 950	110 849	2.66	0.53
Cyprus	930.8	4 743	9 246	51.30	0.85
Denmark	7 259	25 648	43 352	59.16	4.58
Estonia	3 197	9 362	45 339	20.65	1.67
Finland	19 463	21 299	338 198	6.30	3.80
France	8 411	35 334	549 176	6.43	6.31
Germany	3 204	13 727	357 702	3.84	2.45
Greece	18 090	49 442	132 040	37.44	8.83
Ireland	7 711	21 857	69 999	31.22	3.90
Italy	9 136	47 267	301 416	15.68	8.44
Iceland	1 317	30 216	103 000	29.33	5.40
Latvia	645	4 842	64 599	7.50	0.86
Lithuania	46	639	65 292	0.98	0.12
Malta	253	315	315	100.00	0.06
Netherlands	1 571	6 181	37 357	16.55	1.10
Norway	47 236	113 329	323 519	35.03	20.23
Poland	698	4 449	311 896	1.43	0.79
Portugal	2 476	11 863	92 184	12.87	2.11
Romania	428	2 323	237 809	0.98	0.41
Slovenia	48	409	20 275	2.02	0.07
Spain	9 082	38 596	505 990	7.63	6.89
Sweden	21 591	38 256	449 416	8.51	6.83
United Kingdom	21 058	75 024	244 767	30.65	13.40
Average				12.90	
Total	184 659	559 991	4 341 502		100.00

Notes: The coastline length and area of 10 km coastal zone are calculated from the Corine land cover database. These figures may vary from national statistics owing to the inclusion or exclusion of coastal features, such as estuaries, islands and spits. Iceland and Norway are included in this table but not in the assessment. This is due to the fact that their land cover data was not available in the Corine land cover database.

is used as a tool for analysis, but it also serves as a basis for formulating categories of spatial features occurring in coastal zones (e.g. data modelling). The concept of platform also provides a means for data exchange, dissemination and communication of the results. The integrated spatial assessment platform serves as methodological basis for building an integrated spatial information system and developing the spatial data infrastructure at the EEA.

B Methodological issues of coastal integrated assessments

Definition of the coast: spatial units for spatial assessment

Disaggregation of real coastal landscape to arbitrary coastal units is necessary to perform integrated spatial assessment and develop methodologies such as land, water and ecosystem accounts.

Insufficient delimitation of coastal eco-geographic features directly translates into a lack of territorial data for the coast. Therefore, a lack of visibility of coast for both the general public and policymakers results.

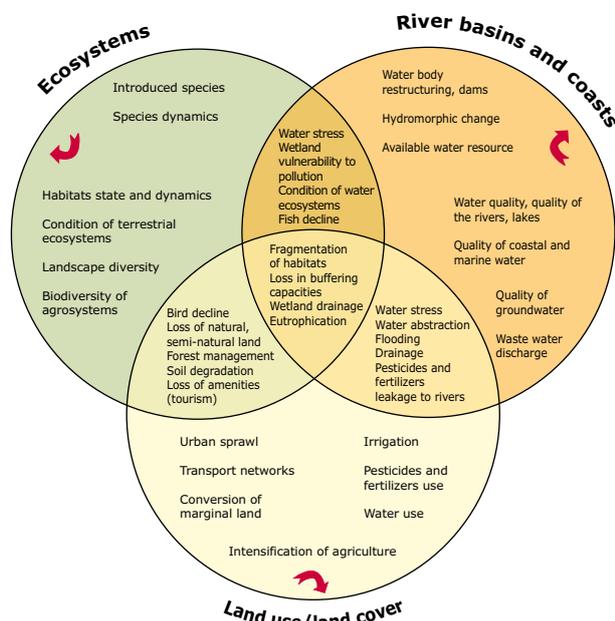
The identification of coastal units, including land and sea, will allow comparisons. Ideally, a good hierarchy of units would be necessary. At the same time, this kind of generic spatial units should be able to accommodate the specific needs of thematic classifications across diverse coastal situations. Therefore, such spatial units have to maintain the connection between the natural characteristics of the coast and coastal management units.

In this report, spatial units are designed to fit the land accounting method. The results of land cover change analysis in 3 x 3 km cells are aggregated to spatial units which are produced by intersecting smoothed land cover areas (dominant landscape

Overview of consultation process for report

Workshop on European coastal indicators and data, 8–9 June 2004, Malta	Blue Plan, PAP-RAC, Black Sea Commission, VASAB2010, WG-ID, GSE Coastwatch
Littoral 2004, 20–21 September, Aberdeen, the United Kingdom	Coastal experts, researchers and stakeholders
WG-ID meeting, 24–26 October 2004, Gdynia, Poland	Members of the group, DEDUCE and SAIL partners
EU ICZM Expert Group, 24 November 2004 Rotterdam, the Netherlands	Progress report from WG-ID and presentation of the background paper
European conference on coastal defence management: European coasts at risk, how to manage? 25 November 2004	Dutch government event at the occasion of the Dutch EU presidency, presentation of main findings from the background paper
European Conference on Coastal Zone Research: an ELOISE approach, 14–18 November 2004, Portoroz, Slovenia	Presentation of relevant EEA activities and needs
CRPM, 1 October 2004, Barcelona	Consultation on priority issues
DG-ENV, 15 November 2004	Consultation on the background draft paper
North Sea Commission's International Conference on ICZM, Ringkoebing, Denmark, 1–3 March 2005	Presentation of the SoC by EEA and discussion/ contributions from participants
Workshop on the State of the EU Coast, 9 March 2005, Barcelona	Consultation to main EU Member States, Expert group on ICZM
WG-ID meeting, 10 March 2005, Barcelona	Consultation to WG-ID participants
Workshop on 'Sustainability ICZM Indicators', 25–26 April 2005, Ireland	Presentation of the SoC by EEA and discussion/ contributions from participants
Meeting with coastal experts, 20–21 April 2005, Barcelona	Consultation with IFEN and UPO (Andalucía)
EEA and ETC's workshop, Paris 2005 (24 May, Paris)	Consultation with ETC-BD, ETC-W and EEA/ETCs collaboration
Network consultation phase, August–September 2005	Consultation with Eionet and the Commission (DG Environment)
Blue Plan and PAP-RAC, October 2005	Consultation with the Mediterranean stakeholders
CPRM, December 2005	Consultation with the CPRM representatives

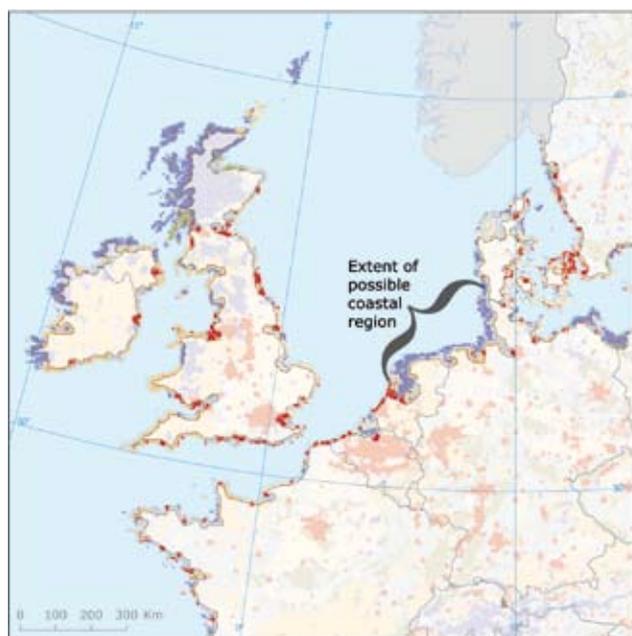
Concept of EEA integrated spatial assessment platform



types) and the 10 km coastal zone. Ideally, the spatial units should be independent of the assessment method.

There are different spatial units being used such as grids, administrative units, river basins, sea catchments, bio-geographical regions and others. Coastal units might be defined as a coastal area that follows the logic of littoral cells — coastal

Coastal assessment regions defined on the basis of natural coastal system can provide spatial units for the coastal assessment



compartments with autonomous sediment balance. Within the limits of littoral cells coastal land cover changes can be assessed on any spatial resolution level.

However, the level of littoral cells may be too detailed for European level assessments and their aggregation in some other meaningful units may be useful. Here, for the purpose of European level assessment, we propose the concept of 'coastal assessment region' (figure and map below). This would be a coastal area that follows the general logic of regional sea coasts but at a lower level. It would be defined as collection of several littoral cells so as to maintain consistency with natural coastal processes. Coastal land cover of such coastal assessment regions can be represented at any resolution, depending on the scale and other needs of assessment. These coastal assessment regions would remain distinctive from other neighbouring coastal assessment regions because of the internally common nature of environmental features on the coasts, and also because of common management co-operation ties, which sometimes may occur across administrative boundaries.

Designed as such, the coastal regions would address the ecosystem approach by following the bio-geographic and oceanographic features and also take in to account existing political, social, economic and management divisions. Typically, coastal regions would often feature a coastal or shoreline management plan and active coordination forum. The new proposal for the Marine Strategy Directive (COM(2005(505)) establishes marine regions and sub-regions, which provides good spatial frameworks for determining coastal regions (assessment regions).

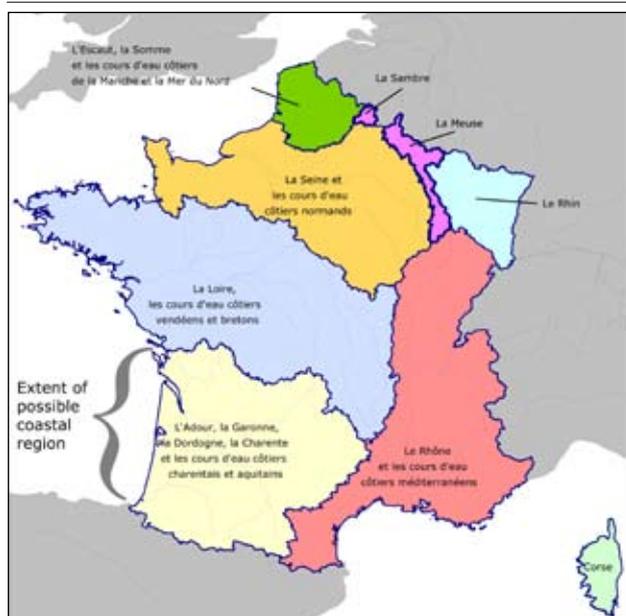
The alternative definition of the coastal assessment region may be developed on the basis of the water framework directive, which provides the

Coastal assessment region in the coastal spatial assessment hierarchy

Generic category	Example
Coast of the continent	European coast
Coast of the regional sea	Coast of North Sea and NE Atlantic
Coast of the sea compartment	Southern North Sea coast
Coastal region	'Wadden Sea' coast
Coastal management unit	A sediment cell

Suitable unit for EU-level assessment?

Coastal assessment region defined as a stretch of coastal water associated with land of nearest (or most appropriate) river basin district(s)



Source: France's river basin districts boundaries courtesy Ministère de l'Ecologie et du Développement Durable, Direction de l'Eau, 2004.

geographical determination of coastal waters. River basin districts also cover respective coastal waters, because coastal waters are defined as surface water. In terms of its chemical status, it shall also include territorial waters (WFD, Art 2). In accordance with the WFD, a 'coastal assessment region' could be a stretch of coastal water associated with land of nearest (or most appropriate) river basin district(s) (see map). The link between river basins and coastal water bodies is stressed in the European strategy for ICZM (2000) which says, 'The Commission will need to work with the Member States to articulate links between river basin plans and other spatial planning for the targeted area, including any coastal zone or structural fund plans'. In this interpretation, a coastal management plan, like flood risk management plan, could be integrated with the river basin management plans of respective river basin districts.

Towards spatial integration of individual indicators

A high complexity of coastal systems creates major challenges for data integration. To be scientifically sound and remain relevant for a coastal context

requires involvement of multi-disciplinary data sources. This situation is even more complicated by the spatial analysis approach. There are huge amounts of different data sources and indicators available for coastal assessment and they need to be integrated in a meaningful way. Different methods of such data integration illustrate the different nature of indicators available for coastal assessment:

- Integration of spatial data sets (GIS manipulation)
- Integration of spatial and non-spatial or spatially scattered information
- Integration of sea and land data and respective knowledge
- Integration along cause-effect chains (DPSIR scheme)
- Integration of economic, environmental and social aspects of sustainable development and respective indicators
- Integration of information related to land, water and biodiversity as the main EEA approach for integrated spatial assessment.

Not all of these data integration lines allow one single assessment. However, even a partial attempt may bring value.

Need to balance the EU and local/regional level approach

The diversity of Europe's coasts is represented by the variability of coastal systems and management models at different administrative levels. This creates the need for multiple approaches in the assessment of the state of the environment within coastal zones. Some indicators may maintain their relevancy regardless of geographic scales span from local to EU level (e.g. hazardous substances in water). Others may be crucial to local level but not EU level (e.g. coastal defence systems). Some issues are best assessed at EU level because the situation needs to be generalised and reasonably aggregated to make it relevant for EU policies (e.g. urban sprawl and urban thematic strategy or sustainable development strategy). This creates the need for separate, but still coordinated assessment levels on an EU and local/regional scale. EU level context needs case studies and local data for the validation of guidelines and recommendations. Local and regional assessments need to be viewed within the broader framework and assistance is needed to recognize the local impacts of EU policies.

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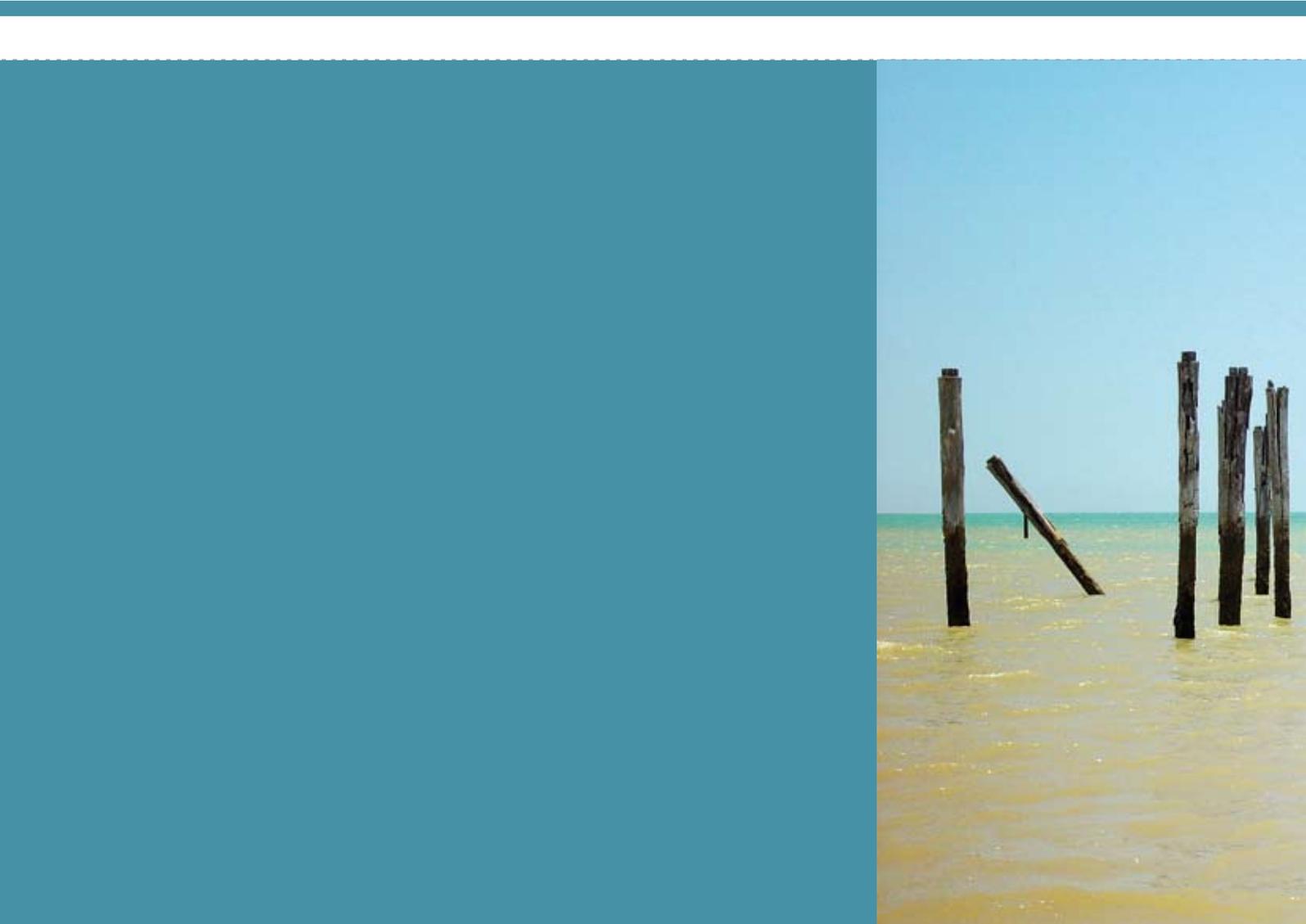
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